

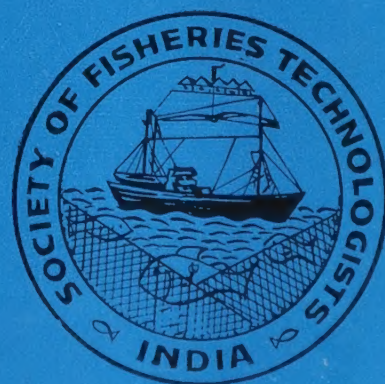
ISSN : 0015-3001



# FISHERY TECHNOLOGY

JULY 1979

VOLUME 16, No. 2



**SOCIETY OF FISHERIES TECHNOLOGISTS (INDIA)**





# ***Fishery Technology***



---

July 1979

Volume 16, No. 2

---

## EDITORIAL BOARD

Editor

**S. Gopalan Nayar**

Members

**N. Unnikrishnan Nair**

**P. A. Perigreen**



Cochin: Society of Fisheries Technologists (India)

# **Society of Fisheries Technologists (India)**

## **Cochin-682 029**

---

### OFFICERS AND COMMITTEE, 1979

#### *President*

**G. K. Kuriyan**

#### *Vice Presidents*

**C. V. Kulkarni**

**N. K. Velankar**

#### *Secretary*

**R. Balasubramanyan**

#### *Assistant Secretary*

**A. Vasanth Shenoy**

#### *Treasurer*

**G. R. Unnithan**

#### *Executive Committee*

**K. K. Balachandran**

**Cyriac Mathen**

**U. K. Gopalan**

**P. D. Antony**

**K. K. P. Menon**

**P. K. Surendran**

**A. K. Jafri**

**A. V. V. Satyanarayana**

**Mary Thomas**

---

**Society of Fisheries Technologists (India)** is established to promote the cause of fisheries in general and fisheries technology in particular in all its aspects by (a) providing a forum for fishery technologists connected with production and processing of fish, design and construction of fishing boats and gear and manufacture of engines, auxiliaries and deck equipments, to meet periodically for discussion, exchange of information, findings and experience on different aspects of fisheries technology, (b) encouraging original investigations on problems related to fisheries technology, (c) publishing a journal called "**Fishery Technology**", (d)

instituting prizes in recognition of outstanding contributions to the advancement of fisheries technology in India and (e) such other means consistent with the aims of the society as the executive committee may decide.

Membership shall be open to all persons interested in fisheries, fisheries technology and fishing industry. Details of further facilities accorded to members and forms of application for membership are available from the Secretary, Society of Fisheries Technologists (India), Matsyapuri P. O., Cochin-682 029, INDIA.



Fishery Technology is published and distributed by the Society of Fisheries Technologists (India). It is published twice a year in January and July.

Single copy of each issue of the journal will be supplied free to the bonafide members of the society. For others the rate of subscription for the journal is as follows:

Overseas      US\$ 12

Inland          Rs. 15

Terms are cash with order or against proforma invoice. Orders and subscriptions should be sent to "**Society of Fisheries Technologists (India)**".

Claims regarding issues lost or damaged in transit should be addressed to the Editor,

Fishery Technology, Matsyapuri P. O., Cochin-682 029, India. Claims cannot be entertained if they are received later than three months after the date of posting plus such time as would be expected for transit by post.

Enquiries for back volumes of the journal should be addressed to the Editor, Fishery Technology, Matsyapuri P.O., Cochin-682 029, India.

The Indian Council of Agricultural Research, New Delhi has given a generous grant of Rs. 7,500/- for 1978-1979 towards the publication of Fishery Technology.

The society and the editorial board assume no responsibility for the statements and views expressed by contributors.

## Contents of Volume 16, No. 2, 1979

|                                                                                                            | PAGE |                                                                                                | PAGE |
|------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------|------|
| Development of trawls for medium sized trawlers for Veraval, North-West coast of India                     |      | Rational exploitation of <i>Catla catla</i> (Ham) from Hirakud reservoir—A preliminary account |      |
| K. K. Kunjipalu, P. George Mathai & A. C. Kuttappan                                                        | 55   | V. C. George, A. A. Khan & M. D. Varghese                                                      | 87   |
| Evolution of suitable net for medium sized vessels-ii Introduction of large meshed high opening fish trawl |      | Effect of electric stimulation on heart beat and body muscle in fish                           |      |
| N. Subramonia Pillai, N. A. George & A. K. Kesavan Nair                                                    | 65   | K. P. Biswas & S. P. Karmarkar                                                                 | 91   |
| Protein hydrolysate from miscellaneous fish                                                                |      | Inshore demersal fisheries off Orissa coast                                                    |      |
| R. Thankamma, K. Gopakumar A. Lekshmy Nair, A. Vasanth Shenoy & M. Arul James                              | 71   | K. P. Biswas                                                                                   | 101  |
| Red and white meat of tuna ( <i>Euthynnus affinis</i> ): Their biochemical role and nutritional quality    |      | Distribution of Vitamin B-12 in some fishes and marine invertebrates                           |      |
| M. K. Mukundan, M. Arul James, A. G. Radhakrishnan & P. D. Antony                                          | 77   | S. K. Chhatbar & N. K. Velankar                                                                | 109  |
| On certain allometric relations of the spiny lobster <i>Panulirus polyphagus</i> (Herbst)                  |      | Letter to the editor                                                                           |      |
| T. Joseph Mathai & A. K. Kesavan Nair                                                                      | 83   | D. R. Chaudhuri & H. Ganguli                                                                   | 113  |
|                                                                                                            |      | Letter to the editor                                                                           |      |
|                                                                                                            |      | T. K. Govindan                                                                                 | 114  |



## INDEX TO AUTHORS

|                   |         |                       |        |
|-------------------|---------|-----------------------|--------|
| Antony, P. D.     | 77      | Karmarkar, S. P.      | 91     |
| Arul James, M.    | 71, 77  | Kesavan Nair, A. K.   | 65, 83 |
| Biswas, K. P.     | 91, 101 | Khan, A. A.           | 87     |
| Chhatbar, S. K.   | 109     | Kunjipalu, K. K.      | 55     |
| Chaudhuri, D. R.  | 113     | Kuttappan, A. C.      | 55     |
| Ganguli, H.       | 113     | Lekshmy Nair, A.      | 71     |
| George, N. A.     | 65      | Mukundan, M. K.       | 77     |
| George, V. C.     | 87      | Radhakrishnan, A. G.  | 77     |
| George Mathai     | 55      | Subramonia Pillai, N. | 65     |
| Gopakumar, K.     | 71      | Thankamma, R.         | 71     |
| Govindan, T. K.   | 114     | Varghese, M. D.       | 87     |
| Joseph Mathai, T. | 83      | Vasanth Shenoy, A.    | 71     |
|                   |         | Velankar, N. K.       | 109    |

# The following papers appeared in the last issue of Fishery Technology

## Contents of Volume 16, No. 1, 1979

|                                                                                                                                                                       | PAGE |                                                                                         | PAGE |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------|------|
| Observations on the wastage of raw material and recovery of meat in the prawn processing industry                                                                     |      | Smoke curing of mussels                                                                 |      |
| A.K. Kesavan Nair, P. Srinivasa Rao, G.R. Unnithan & P.N.R. Kaimal                                                                                                    | 1    | V. Muraleedharan, T. S. Unnikrishnan Nair & K. George Joseph                            | 29   |
| Studies on the influence of moisture and specific gravity on the strength properties of mango wood ( <i>Mangifera indica</i> )                                        |      | A method for the preparation of cooked-peeled-frozen prawns                             |      |
| N. Unnikrishnan Nair, K. Ravindran & A. G. Gopalakrishna Pillai                                                                                                       | 7    | Cyriac Mathen, Annamma Mathew, P.R. Girija Varma & Francis Thomas                       | 33   |
| Investigations on long distance transportation of fish-V Transporation of filleted and round seer fish ( <i>Scomberomorus sp.</i> ) from Kakinada to Calcutta by rail |      | Nutritive value of the crab <i>Podophthalmus vigil</i> (Fabricius)                      |      |
| C. C. Panduranga Rao, T. K. Govindan, Sibsankar Gupta & P. Chattopadhyay                                                                                              | 11   | C. K. Radhakrishnan & R. Natarajan                                                      | 37   |
| Studies on the growth temperature ranges of bacteria isolated from fresh sardine at different primary incubation temperatures                                         |      | Seasonal changes in the biochemical composition of liver in <i>Garra mullya</i> (Sykes) |      |
| Nirmala Thampuran & K. Mahadeva Iyer                                                                                                                                  | 15   | V.S. Somvanshi                                                                          | 39   |
| A new large mesh trawl for demersal fishery                                                                                                                           |      | Filleting of fish and utilization of filleting waste                                    |      |
| K. K. Kunjipalu, A. C. Kuttappan & P. George Mathai                                                                                                                   | 19   | P. A. Perigreen, A. Lekshmy Nair & P. V. Prabhu                                         | 43   |
|                                                                                                                                                                       |      | Studies on smoke curing and preservation of oil sardine ( <i>Sardinella longiceps</i> ) |      |
|                                                                                                                                                                       |      | T. C. Chandrasekhar, T. M. Rudra Setty & K. S. Udupa                                    | 47   |
|                                                                                                                                                                       |      | Letter to the editor                                                                    |      |
|                                                                                                                                                                       |      | T. K. Govindan                                                                          | 53   |



## INSTRUCTIONS TO AUTHORS

Papers submitted for publication in *Fishery Technology* should be typewritten double space on one side of the paper only, in duplicate. The manuscript should be in the final form and no alterations or additions are allowed at the proof stage. Typescripts that are not concise or do not conform to the conventions of *Fishery Technology* will be returned to the author for revision. Papers should be sent to the Editor, Fishery Technology, Matsyapuri P.O., Cochin-682 029, India.

Contributions from authors who are members of the Society of Fisheries Technologists (India) and who do not owe dues of any sort to the society alone will be considered for publication. Non-members who are desirous of publishing papers in *Fishery Technology* shall enroll themselves as members of the society paying the prescribed subscription and admission fee.

Original research papers, short notes and review articles on fishery technology or any other branch of marine science will be accepted for publication.

Papers should be headed by a concise but informative full title, by the names of the authors (name in full with initials for each author) and the name and address of the establishment where the work was performed. (foot notes, indicating present addresses may be included on the title page). Titles of papers should be sufficiently descriptive and informative about the contents so that the titles can be used in indexing and in coding for information, storage and retrieval. Authors should also give a shortened version of the titles not exceeding 60 letters and spaces suitable for a running title.

Papers are divided into the following sections:

(a) The *synopsis* should contain a brief but informative summary of the contents and conclusions of the paper and

should also highlight any new information contained in the paper. Normally the synopsis should not exceed 250 words and should be in the form acceptable to abstracting journals; (b) *Introduction* should contain the purpose of the investigation and its relation to other works in the same field; (c) *Materials and Methods*; (d) *Results and Discussion*. The results may be presented in the text or in tables or figures and should be described with a minimum of discussion. Both tables and figures illustrating the same results will not be permitted. Drawings or illustrations should be made in Indian ink on tracing paper, approximately twice the dimension of the finished product as it will appear in the journal (usually single column width); (e) *Acknowledgements*; (f) *References*. The Harvard system, not the numbering system should be used for the citation of references in the text, as follows: For paper written by one or two authors, as 'Finch (1956)' or '(Finch, 1956)' or 'Brewer & Stewer (1942)' or '(Brewer & Stewer, 1942)'. For papers written by three or more authors as 'Smith *et al.* (1957)' or '(Smith *et al.*, 1957)'. Where more than one paper by the same authors, it should be given as 'Brewer & Stewer (1956 a, b)' or '(Brewer & Stewer, 1956 a, b)'. At the end of the paper, references should be listed in *alphabetical* order except for papers by three or more authors (which are given in the text only as *et al.*), which should be grouped in chronological order after any other papers by the first author. The authors' initials should be included, but not the title of the paper. Examples:

Finch, G. I. (1956) *J. Sci. Ind. Res.* **15**, 539

Pope, C.G. & Stevens, M.F. (1939)  
*Biochem. J.* **33**, 1070

Krebs, H.A., Speake, R.N. & Hems, R.  
(1965) *Biochem J.* **94**, 712

Mavinkurve, S.S., Gangal, S.V., Savant,  
P.L. & Kumta, U.S. (1967) *J. Fd  
Sci.* **32**, 711



It should be noted that the year, volume number and first page should be cited for references.

Titles of journals should be abbreviated in accordance with World List of Scientific Periodicals, 4th edition and supplements.

References to books and monographs should include names of editors, edition number, volume number, relevant page numbers, name of publisher and town where published. Examples:

Benyami, M. (1959) in *Modern Fishing Gear of the World* (Kristjonsson, H., Ed.), Vol. 1, p. 213, Fishing News (Books) Ltd., London

Schultz, H. W. (1960) *Food Enzymes*, 1st edn., p. 65, The AVI Publishing Company Inc., U.S.A.

All units should be expressed in metric system. Figures in the text should be given Arabic numerals and their position appropriately marked in the text. All figures should have captions. Tables (as few as possible) should be typed on separate paper and should be given Arabic numerals and their position marked in the text. Each table should have a caption.

For every contribution the author will be supplied fifteen gratis reprints in the case of single author and ten reprints each in the case of joint authorship. Number of extra copies required (with or without cover) at cost price plus postage must be communicated to the Editor, on receipt of communication regarding acceptance of the paper for publication.

The number of words per article should be restricted to 3,000 for review articles, 2,000 for research papers and 1,000 for notes.



**Statement about ownership and other particulars about the newspaper (journal)**

**“FISHERY TECHNOLOGY”**

(To be published in the first issue every year after the last day of February)

(Form IV)

(See Rule 8)

- |                               |                                                        |
|-------------------------------|--------------------------------------------------------|
| 1. Place of publication       | : Cochin-682 029                                       |
| 2. Periodicity of publication | : Six monthly                                          |
| 3. Printer's name             | : S. Gopalan Nayar                                     |
| Nationality                   | : Indian                                               |
| Address                       | : C/o C. I. F. T., Matsyapuri P. O.,<br>Cochin-682 029 |
| 4. Publisher's name           | : S. Gopalan Nayar                                     |
| Nationality                   | : Indian                                               |
| Address                       | : C/o C. I. F. T., Matsyapuri P. O.,<br>Cochin-682 029 |
| 5. Editor's name              | : S. Gopalan Nayar                                     |
| Nationality                   | : Indian                                               |
| Address                       | : C/o C. I. F. T., Matsyapuri P.O.,<br>Cochin-682 029  |

I, S. Gopalan Nayar, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Cochin-682 029  
26-12-1979

Sd/-  
S. Gopalan Nayar  
Editor & Publisher





## Development of Trawls for Medium Sized Trawlers for Veraval, North-West Coast of India

K. K. KUNJIPALU, P. GEORGE MATHAI AND A. C. KUTTAPPAN

Comparative fishing experiments with 25 m bulged belly and 25 m six seam trawls were carried out to study the relative efficiency of the gear. Bulged belly trawl was found more efficient than the other at depths below 40 m. The tension and horizontal opening were more in bulged belly and six seam trawl respectively. Bulged belly caught more of prawns and lobsters but there was no significant difference in the catch of sciaenids, cephalopods and ribbon fishes in the two nets.

Varghese *et al.* (1968) reported bulged belly trawls as more suitable for prawns and fishes off Cochin. Pillai *et al.* (1978) observed bulged belly trawl quite appropriate for bottom and column fishes in depths 20-40 m off Cochin. Deshpande *et al.* (1970) studied the suitability of six seam trawl off Veraval. However, systematic attempts were not made to study the operational characteristics and relative efficiency of the above two nets. Experiments carried out by the authors with the two types of nets are presented in this communication.

### Materials and Methods

A bulged belly trawl with 25 m head rope and a six seam trawl of 25 m head rope as described by Deshpande *et al.* (1970) were operated together with flat rectangular otter boards of 1524 mm  $\times$  762 mm size weighing 100 kg each in air (Kuriyan *et al.*, 1964). Fishing conducted in 1977 from the institute vessel Fishtech 8, 15.2 m OAL and fitted with 165 HP engine. The depth of the fishing ground varied from 26 to 55 m off Veraval.

The details of the two nets are shown in Figures 1 & 2 and Tables 1a, 1b, 1c, 2a, 2b, 2c and 3. Both the nets were operated the same day keeping depth, ground, length of warp, trawling speed, duration of each haul and course constant. Each net was provided with a double sweep line of 5 m long in between the net leg and otter board.

\*Present Address: Central Institute of Fisheries Technology, Cochin-682 029

Towing warp tension and horizontal opening between otter boards were recorded as described by Benyami (1959), Deshpande (1960) and Satyanarayana & Nair (1965). The catch and composition of each haul were recorded separately for the two gears. 74 hauls, each of one hour duration with both nets were made. The nets landed a total of 13,658.650 kg fish.

### Results and Discussion

The results of comparative hauls made at two depth zones, namely upto 40 m (26-39 m) and beyond 40 m (40-55 m) are presented in Table 4 and composition of catch in Table 5. Analysis of variance of data for 26-39 m and 40-55 m are given in Tables 6 and 7. For analysis, data on catch and tension were converted to their log values. Analysis were done separately for 26-39 m and 40-55 m. From Table 4 and 5 it is clear that the bulged belly is more efficient than the six seam trawl with respect to catch. In shallow waters (upto 40 m) the total catch of the two nets showed (Table 6c) a significant difference ( $p < 0.05$ ). Quality fishes, sciaenids, cephalopods and ribbon fishes landed by the two nets were not significant at 5% level. But there was a significant difference ( $p < 0.01$ ) in the landing of miscellaneous fishes, prawns and lobsters in the two nets. Bulged belly trawl landed more from the two depth zones compared to six seam trawl (Tables 6 g and 6 h). Same trend was observed in deeper waters (beyond 40 m). Significant difference ( $p < 0.01$ ) in the prawn and lobster catches of

the two nets was observed (Table 7 g). The difference in the total catch of the two nets was significant at 5% level only (Table 7c) in deeper waters. However this may be confirmed by further studies. The increase in the catch of six seam net in deeper waters (Table 4 and 5) was due to the increased landings of ribbon fishes at random where as all the other fishes were caught at par with that of bulged belly trawl. It may be concluded that the bulged belly trawl may be more efficient in catching the 'shallow water mix' consisting mainly of small miscellaneous fishes and crustaceans which are more abundant there than in deeper waters. Similar observations were also made by Pillai *et al.* (1978) in shallow waters (20-40m) off Cochin.

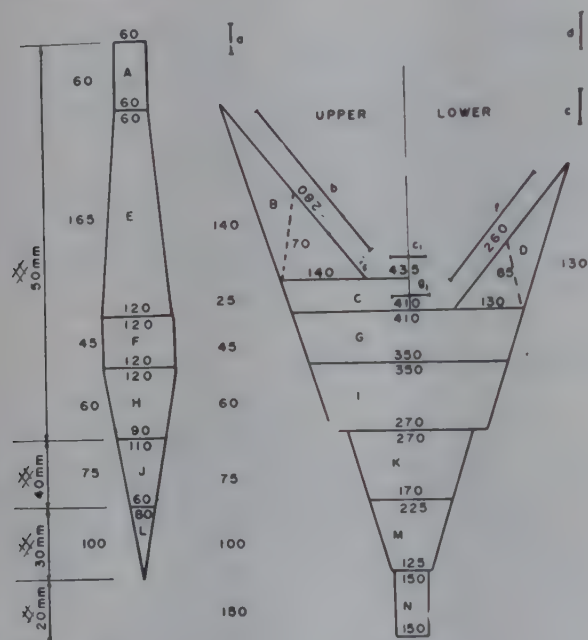


Fig. 1. 25 m bulged belly trawl

The percentage horizontal opening of the two nets differ significantly ( $p < 0.01$ ). Six seam trawl had higher percentage opening compared to bulged belly trawl at all depths (Tables 4, 6b, and 7b). Reduced horizontal spread of bulged belly trawl may be due to increased bottom friction. Factors like smaller mesh size, many meshes and larger quantity of twine in bulged belly trawl (Table 3) would have offered more resistance which in turn might have reduced the horizontal spread. This was evident in shallow waters where bottom friction was more. However, there was no corresponding increase of catch in relation to the increased horizontal opening

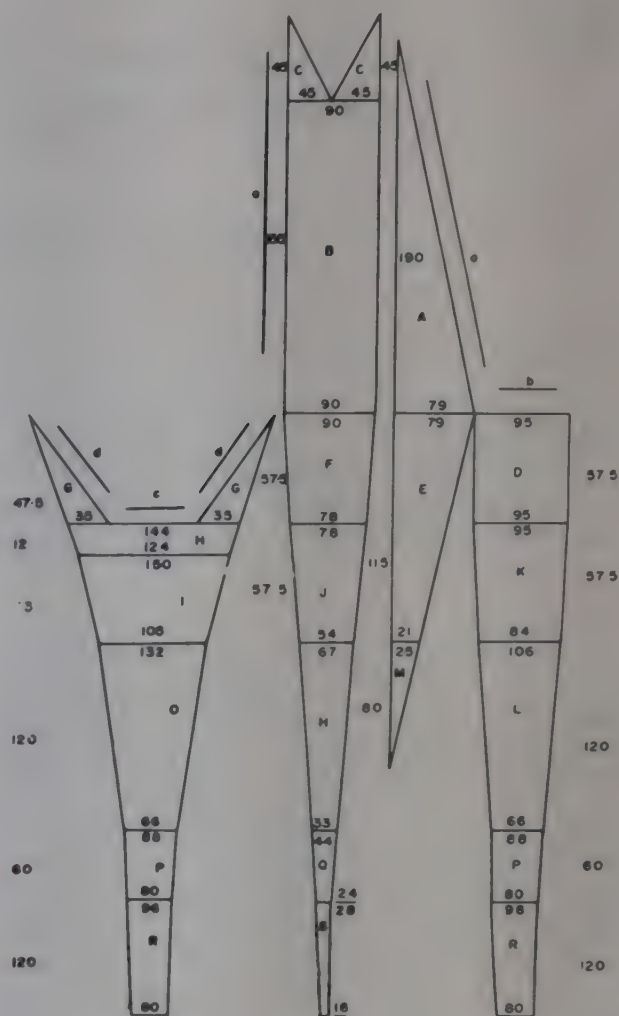


Fig. 2. 25 m six seam trawl

of six seam trawl in shallow waters. It may be noted that the increased horizontal opening obtained by six seam trawl had no added advantage over the bulged belly trawl in shallow waters.

The trawl warp tension offered by the two nets was significantly different ( $p < 0.01$ ). The bulged belly trawl had more tension compared to six seam trawl (Table 4, 6a, and 7a) at all depths. This is in accordance with the above findings that bulged belly trawl was offering more resistance indicated by the increased warp tension. Factors offering more resistance might have produced increased warp tension as the other parameters were kept constant. In all the cases between days variations were highly significant ( $p < 0.01$ ).

As the catching efficiency of bulged belly trawl was found to be more in shallow waters it can be recommended for the exploitation



Table 1a. Details of 25 m six seam bulged belly trawl\*

|                         |                                     |                                    |                                 |      |     |       |                                 |                                 |       |       |      |     |       |     |       |      |     |      |      |
|-------------------------|-------------------------------------|------------------------------------|---------------------------------|------|-----|-------|---------------------------------|---------------------------------|-------|-------|------|-----|-------|-----|-------|------|-----|------|------|
| Webbing                 | A                                   | B                                  | C                               | D    | E   | F     | G                               | H                               | I     | J     | K    | L   | M     | N   | O     | P    | Q   | R    | S    |
| Twine diameter mm       | 15                                  |                                    |                                 |      |     |       |                                 |                                 |       |       |      |     |       |     |       |      |     |      |      |
| Breaking strength kg    | 36                                  |                                    |                                 |      |     |       |                                 |                                 |       |       |      |     |       |     |       |      |     |      |      |
| Stretched mesh mm       | 63                                  | 63                                 | 63                              | 63   | 63  | 63    | 63                              | 76                              | 76    | 63    | 63   | 50  | 50    | 50  | 50    | 38   | 38  | 31   | 31   |
| Upper edge meshes       | 1                                   | 90                                 | 1                               | 95   | 79  | 90    | 1                               | 144                             | 150   | 70    | 95   | 106 | 25    | 67  | 132   | 88   | 44  | 96   | 28   |
| Lower edge meshes       | 79                                  | 90                                 | 45                              | 95   | 21  | 78    | 35                              | 124                             | 105   | 54    | 84   | 66  | 1     | 33  | 66    | 80   | 24  | 80   | 16   |
| Depth meshes            | 190                                 | 155                                | 45                              | 57.5 | 115 | 57.5  | 47.5                            | 12                              | 43    | 57.5  | 57.5 | 120 | 80    | 120 | 120   | 60   | 60  | 120  | 120  |
| Baiting rate            |                                     |                                    |                                 |      |     |       |                                 |                                 |       |       |      |     |       |     |       |      |     |      |      |
| Inner                   | ...                                 | ...                                | ...                             | ...  | ... | ...   | 1:4                             | ...                             | ...   | ...   | ...  | ... | ...   | ... | ...   | ...  | ... | ...  | ...  |
| Outer                   | 1:2.4                               | ...                                | 1:1                             | ...  | 1:2 | 1:4.8 | 1:1                             | 1:1.2                           | 1:1.9 | 1:2.4 | 1:5  | 1:6 | 1:3.3 | 1:7 | 1:3.6 | 1:15 | 1:6 | 1:15 | 1:20 |
| Co-efficient of hanging | 0.87                                | 0.87                               | 0.87                            | 0.50 | ... | ...   | 0.97                            | 0.50                            |       |       |      |     |       |     |       |      |     |      |      |
| Hanging                 | $\frac{a}{A+C} = \frac{11.0}{12.6}$ | $\frac{c}{BC} = \frac{11.0}{12.6}$ | $\frac{b}{D} = \frac{3.0}{6.0}$ | ...  | ... | ...   | $\frac{d}{G} = \frac{3.5}{3.6}$ | $\frac{e}{H} = \frac{2.8}{5.6}$ |       |       |      |     |       |     |       |      |     |      |      |

\* Blue high density polyethylene with single trawl knot  
Total weight of the net 45 kg

of 'shallow water mix'. Both the nets were found equally effective for the capture of all other varieties of fishes. Six seam trawl was cheaper (32.4%) and with lesser warp tension (7.6% in shallow and 4% in deeper waters) than bulged belly trawl. This indicates the possibility of either six seam trawl to be increased in size or it be towed at a faster speed with the given engine power.

The authors are grateful to Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology, for his keen interest and encouragements, to Shri R. Venkataraman for providing necessary facilities, Shri H. Krishna Iyer for the statistical analysis, Shri R. Balasubramanian and Shri K. A. Sadanandan for suggestions. Thanks are also due to Shri M. S. Fernando, skipper and his crew for their help in fishing.

**Table 1b.** *Details of lines and ropes\**

|                      | a                         | b                 | c    | d    | e    |
|----------------------|---------------------------|-------------------|------|------|------|
| Material             | High density polyethylene |                   |      |      |      |
| Diameter mm          | 18                        | 18                | 18   | 18   | 18   |
| Breaking strength kg | 3460                      | 3460              | 3460 | 3460 | 3460 |
| Length m             | 11.0                      | 3.0               | 2.8  | 3.5  | 11.0 |
| * Head rope: 25 m    |                           | *Foot rope: 31.8m |      |      |      |

**Table 1c.** *Details of floats, sinkers and otter boards*

|                    | Floats       | Sinkers    | Otter boards     |
|--------------------|--------------|------------|------------------|
| Number             | 11           | —          | 2                |
| Material           | Hard plastic | Iron       | Iron and wood    |
| Shape              | Spherical    | Link chain | Rectangular flat |
| Diameter mm        | 150          | 6          | —                |
| Length mm          | —            | —          | 1524             |
| Breadth mm         | —            | —          | 762              |
| Static buoyancy kg | 1.550 each   | —          | —                |
| Weight in air kg   | 0.300 each   | 30.0       | 100.0 each       |



Table 2a. Details of 25 m bulged belly trawl\*

| Webbing                 | A                                 | B                                  | C                                 | D                                 | E                                 | F                                 | G                                 | H    | I     | J    | K     | L     | M    | N   |
|-------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|------|-------|------|-------|-------|------|-----|
| Twine diameter mm       |                                   |                                    |                                   |                                   |                                   |                                   | 1.5                               |      |       |      |       |       |      | 2   |
| Breaking strength kg    |                                   |                                    |                                   |                                   |                                   |                                   | 36                                |      |       |      |       |       |      | 45  |
| Stretched mesh mm       | 50                                | 50                                 | 50                                | 50                                | 50                                | 50                                | 50                                | 50   | 50    | 40   | 40    | 30    | 30   | 20  |
| Upper edge meshes       | 60                                | 1                                  | 435                               | 1                                 | 60                                | 120                               | 410                               | 120  | 350   | 110  | 270   | 80    | 225  | 150 |
| Lower edge meshes       | 60                                | 140                                | 410                               | 130                               | 120                               | 120                               | 350                               | 90   | 270   | 60   | 170   | 1     | 125  | 150 |
| Depth meshes            | 60                                | 140/280                            | 25                                | 130/260                           | 165                               | 45                                | 45                                | 60   | 60    | 75   | 75    | 100   | 100  | 150 |
| Baiting rate            | ...                               | 1:2                                | 1:2                               | 1:2                               | 1:5.5                             | ...                               | 1:1.5                             | 1:4  | 1:1.5 | 1:3  | 1:1.5 | 1:2.5 | 1:2  | —   |
| Cutting rate            | ...                               | 1p2b                               | 1p2b                              | 1p2b                              | 4p2b<br>5p2b                      | ...                               | 1p4b                              | 3p2b | 1p4b  | 1p1b | 1p4b  | 3p4b  | 1p4b | —   |
| Co-efficient of hanging | 0.75                              | 0.60                               | 0.45                              | 0.75                              | 0.90                              | 0.58                              | 0.47                              |      |       |      |       |       |      |     |
| Hanging                 | $\frac{a}{A} = \frac{2.25}{3.00}$ | $\frac{b}{B} = \frac{8.50}{14.00}$ | $\frac{c}{C} = \frac{3.50}{7.75}$ | $\frac{d}{A} = \frac{2.25}{3.00}$ | $\frac{e}{E} = \frac{1.50}{1.65}$ | $\frac{f}{D} = \frac{7.5}{13.00}$ | $\frac{g}{G} = \frac{3.50}{7.50}$ |      |       |      |       |       |      |     |

\*Blue high density polyethylene with single trawl knot      Total weight of the net    57 kg

**Table 2b.** *Details of lines and ropes\**

|                      | a                         | b    | c    | d    | e    | f    | g    | leg  | leg  |
|----------------------|---------------------------|------|------|------|------|------|------|------|------|
| Material             | High density polyethylene |      |      |      |      |      |      |      |      |
| Diameter mm          | 18                        | 18   | 18   | 18   | 18   | 18   | 18   | 18   | 18   |
| Breaking strength kg | 3460                      | 3460 | 3460 | 3460 | 3460 | 3460 | 3460 | 3460 | 3460 |
| Length m             | 2.25                      | 8.50 | 3.50 | 2.25 | 1.50 | 7.50 | 3.50 | 5.00 | 5.00 |
| * Head rope: 25 m    | *Foot rope: 26 m          |      |      |      |      |      |      |      |      |

**Table 2c.** *Details of floats, sinkers and otter boards*

|                     | Floats         | Sinkers    | Otter boards     |
|---------------------|----------------|------------|------------------|
| Number              | 11             | —          | 1 pair           |
| Material            | Plastic (hard) | Iron       | Iron and wood    |
| Shape               | Spherical      | Link chain | Rectangular flat |
| Diameter mm         | 150            | 6          | —                |
| Length × breadth mm | —              | —          | 1524 × 762       |
| Static buoyancy kg  | 1.550 each     | —          | —                |
| Weight in air kg    | 0.300 each     | 30.00      | 100 each         |

**Table 3.** *Comparative details of the two nets*

| Particulars                    | 25 m bulged belly trawl | 25 m six seam trawl |
|--------------------------------|-------------------------|---------------------|
| Total number of meshes         | 3,33,000                | 1,72,000            |
| Range of mesh size mm          | 20–50                   | 30–75               |
| Quantity of twine kg           | 40                      | 25                  |
| Quantity of ropes and lines kg | 17                      | 20                  |
| Cost of materials Rs           | 1,425                   | 1,125               |
| Fabrication charges Rs         | 1,200                   | 650                 |
| Total cost Rs                  | 2,625                   | 1,775               |



**Table 4.** *Results of comparative fishing with 25m bulged belly trawl and 25m six seam trawl*

| Particulars                          | 26-39 m depth                  |                                | 40-55 m depth                  |                                |
|--------------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
|                                      | 25m bulged belly trawl         | 25m six seam trawl             | 25m bulged belly trawl         | 25m six seam trawl             |
| Number of hauls                      | 57                             | 57                             | 17                             | 17                             |
| Duration h                           | 57                             | 57                             | 17                             | 17                             |
| Trawl warp tension kg                |                                |                                |                                |                                |
| Average                              | 522.6                          | 482.9                          | 542.0                          | 521.0                          |
| Range                                | 448-658                        | 403-605                        | 425-684                        | 425-630                        |
| Horizontal opening at otter boards m |                                |                                |                                |                                |
| Average                              | 18.83 (41.34 %)                | 22.80 (50.78 %)                | 25.87 (57.50 %)                | 29.68 (66 %)                   |
| Range                                | 15.52-24.73<br>(34.54-54.95 %) | 17.78-28.67<br>(39.63-63.72 %) | 23.50-28.50<br>(52.22-63.33 %) | 28.12-30.98<br>(62.48-68.80 %) |
| Total catch kg                       | 5679.55                        | 4591.35                        | 1362.45                        | 2025.30                        |
| Catch per unit effort kg/h           | 99.64                          | 80.55                          | 80.14                          | 119.13                         |
| Range                                | 11.25-716                      | 1.60-475                       | 15.10-196                      | 9.20-339.5                     |

**Table 5.** *Composition of catch in 25m bulged belly trawl and 25m six seam trawl*

|                      | 26-39m depth           |      |                    |      | 40-55m depth           |      |                    |      |
|----------------------|------------------------|------|--------------------|------|------------------------|------|--------------------|------|
|                      | 25m bulged belly trawl |      | 25m six seam trawl |      | 25m bulged belly trawl |      | 25m six seam trawl |      |
|                      | kg                     | %    | kg                 | %    | kg                     | %    | kg                 | %    |
| Quality fishes       | 76.95                  | 37.3 | 129.40             | 62.7 | 112.50                 | 60.3 | 73.95              | 39.7 |
| Ribbon fish          | 1185.05                | 54.0 | 1013.45            | 46.0 | 195.50                 | 19.5 | 808.00             | 80.5 |
| Sciaenids            | 450.00                 | 52.5 | 405.00             | 47.5 | 7.00                   | 23.3 | 23.00              | 76.7 |
| Lactarius            | 717.00                 | 70.2 | 303.00             | 29.8 | 24.00                  | 40.0 | 36.00              | 60.0 |
| Elasmobranchs        | 3.35                   | 7.0  | 45.30              | 93.0 | 17.50                  | 43.5 | 22.80              | 56.5 |
| Cephalopods          | 150.00                 | 55.0 | 123.00             | 45.0 | 103.50                 | 50.8 | 100.00             | 49.2 |
| Prawns and lobsters  | 70.20                  | 63.0 | 41.00              | 37.0 | 10.45                  | 61.4 | 6.55               | 38.6 |
| Miscellaneous fishes | 3027.00                | 54.4 | 2531.20            | 45.6 | 902.00                 | 48.6 | 955.00             | 51.4 |
| Total                | 5679.55                | 55.2 | 4591.35            | 44.8 | 1372.45                | 40.5 | 2025.30            | 59.5 |

**Table 6a.** *Anova of tension (26-39m)*

| Source | ss     | df  | ms     | f       |
|--------|--------|-----|--------|---------|
| Total  | 0.2334 | 113 |        |         |
| Nets   | 0.0300 | 1   | 0.0300 | 33.33** |
| Days   | 0.1497 | 56  | 0.0026 | 2.89**  |
| Error  | 0.0537 | 56  | 0.0009 |         |

|              |                    |                |
|--------------|--------------------|----------------|
| Mean Tension | Bulged belly trawl | Six seam trawl |
|--------------|--------------------|----------------|

|           |        |        |
|-----------|--------|--------|
| Log units | 2.7140 | 2.6815 |
| Actual kg | 517.60 | 480.30 |

\*\*P&lt;0.01

**Table 6b.** *Anova of percentage opening (26-39m)*

| Source | ss        | df  | ms        | f        |
|--------|-----------|-----|-----------|----------|
| Total  | 6361.3546 | 113 |           |          |
| Nets   | 2264.6107 | 1   | 2264.6107 | 931.75** |
| Days   | 3961.1332 | 56  | 70.7345   | 29.10**  |
| Error  | 136.1107  | 56  | 2.4305    |          |

|                |                        |       |
|----------------|------------------------|-------|
| Mean % opening | 25m bulged belly trawl | 41.87 |
|                | 25m six seam trawl     | 50.78 |

\*\*P&lt;0.01

**Table 6c.** *Anova of total catch*

| Source | ss      | df  | ms     | f      |
|--------|---------|-----|--------|--------|
| Total  | 19.1088 | 113 |        |        |
| Nets   | 0.3639  | 1   | 0.3639 | 5.78*  |
| Days   | 15.2119 | 56  | 0.2716 | 4.31** |
| Error  | 3.5330  | 56  | 0.0630 |        |

|                  |                        |                    |
|------------------|------------------------|--------------------|
| Mean total catch | 25m bulged belly trawl | 25m six seam trawl |
|------------------|------------------------|--------------------|

|           |        |        |
|-----------|--------|--------|
| Log units | 1.8344 | 1.7214 |
| Actual kg | 68.29  | 52.65  |

\*P&lt;0.05

\*\*P&lt;0.01

**Table 6d.** *Anova of quality fishes (26-39m)*

| Source | ss      | df  | ms     | f      |
|--------|---------|-----|--------|--------|
| Total  | 15.0804 | 113 |        |        |
| Nets   | 0.2207  | 1   | 0.2207 | 3.22   |
| Days   | 11.0235 | 56  | 0.1968 | 2.87** |
| Error  | 3.8362  | 56  | 0.0685 |        |

\*\*P&lt;0.01

**Table 6e.** *Anova of sciaenids (26-39m)*

| Source | ss      | df  | ms     | f       |
|--------|---------|-----|--------|---------|
| Total  | 33.6113 | 113 |        |         |
| Nets   | 0.0091  | 1   | 0.0091 | 0.24    |
| Days   | 31.4677 | 56  | 0.5619 | 14.75** |
| Error  | 2.1345  | 56  | 0.0381 |         |

\*\*P&lt;0.01

**Table 6f.** *Anova of cephalopods (26-39m)*

| Source | ss      | df  | ms     | f      |
|--------|---------|-----|--------|--------|
| Total  | 15.2840 | 113 |        |        |
| Nets   | 0.0806  | 1   | 0.0806 | 1.97   |
| Days   | 12.9107 | 56  | 0.2305 | 5.64** |
| Error  | 2.2927  | 56  | 0.0409 |        |

\*\*P&lt;0.01

**Table 6g.** *Anova of prawns and lobsters (26-39m)*

| Source | ss     | df  | ms     | f       |
|--------|--------|-----|--------|---------|
| Total  | 6.3242 | 113 |        |         |
| Nets   | 0.1679 | 1   | 0.1679 | 10.43** |
| Days   | 5.2497 | 56  | 0.0937 | 5.82**  |
| Error  | 0.9066 | 56  | 0.0161 |         |

|            |                    |                |
|------------|--------------------|----------------|
| Mean catch | Bulged belly trawl | Six seam trawl |
|------------|--------------------|----------------|

|           |        |        |
|-----------|--------|--------|
| Log units | 0.2620 | 0.1852 |
| Actual kg | 1.828  | 1.531  |

\*\*P&lt;0.01



**Table 6h.** *Anova of miscellaneous fishes (26-39m)*

| Source | ss      | df  | ms     | f       |
|--------|---------|-----|--------|---------|
| Total  | 23.6974 | 113 |        |         |
| Nets   | 4.7832  | 1   | 4.7832 | 48.66** |
| Days   | 13.4077 | 56  | 0.2394 | 2.44**  |
| Error  | 5.5065  | 56  | 0.0983 |         |

|            |                    |                |
|------------|--------------------|----------------|
| Mean catch | Bulged belly trawl | Six seam trawl |
| Log units  | 1.8376             | 1.4279         |
| Actual kg  | 68.80              | 26.79          |

\*\*P<0.01

**Table 6i.** *Anova of ribbon fishes (26-39m)*

| Source | ss      | df  | ms     | f      |
|--------|---------|-----|--------|--------|
| Total  | 47.3075 | 113 |        |        |
| Nets   | 0.2467  | 1   | 0.2467 | 1.80   |
| Days   | 39.3923 | 56  | 0.7034 | 5.14** |
| Error  | 7.6685  | 56  | 0.1369 |        |

\*\*P< 0.01

**Table 7a.** *Anova of tension (40-55m)*

| Source | ss     | df | ms     | f       |
|--------|--------|----|--------|---------|
| Total  | 0.0744 | 33 |        |         |
| Nets   | 0.0026 | 1  | 0.0026 | 26.00** |
| Days   | 0.0704 | 16 | 0.0044 | 44.00*  |
| Error  | 0.0014 | 16 | 0.0001 |         |

|              |                    |                |
|--------------|--------------------|----------------|
| Mean tension | Bulged belly trawl | Six seam trawl |
| Log units    | 2.7316             | 2.7141         |
| Actual kg    | 539.1              | 517.7          |

\*\*P<0.01

**Table 7b.** *Anova of percentage opening (40-55m)*

| Source | ss       | df | ms       | f        |
|--------|----------|----|----------|----------|
| Total  | 914.3359 | 33 |          |          |
| Nets   | 607.0903 | 1  | 607.0903 | 338.80** |
| Days   | 278.5733 | 16 | 17.4108  | 9.72**   |
| Error  | 28.6713  | 16 | 1.7919   |          |

|                |                    |                |
|----------------|--------------------|----------------|
| Mean % opening | Bulged belly trawl | Six seam trawl |
|                | 57.50              | 65.96          |

\*\*P<0.01

**Table 7c.** *Anova of total catch (40-55m)*

| Source | ss     | df | ms     | f      |
|--------|--------|----|--------|--------|
| Total  | 5.1061 | 33 |        |        |
| Nets   | 0.0280 | 1  | 0.0280 | 0.55   |
| Days   | 4.2662 | 16 | 0.2666 | 5.26** |
| Error  | 0.8119 | 16 | 0.0507 |        |

\*\*P<0.01

**Table 7d.** *Anova of ribbon fishes (40-55m)*

| Source | ss      | df | ms     | f     |
|--------|---------|----|--------|-------|
| Total  | 11.7605 | 33 |        |       |
| Nets   | 0.1798  | 1  | 0.1798 | 1.05  |
| Days   | 8.8404  | 16 | 0.5525 | 3.23* |
| Error  | 2.7403  | 16 | 0.1712 |       |

\*P<0.05

**Table 7e.** *Anova of quality fishes (40-55m)*

| Source | ss     | df | ms     | f     |
|--------|--------|----|--------|-------|
| Total  | 9.0344 | 33 |        |       |
| Nets   | 0.1654 | 1  | 0.1654 | 0.09  |
| Days   | 6.4391 | 16 | 0.4024 | 2.65* |
| Error  | 2.4299 | 16 | 0.1518 |       |

\*P<0.05

**Table 7f.** *Anova of cephalopods (40-55m)*

| Source | ss     | df | ms     | f      |
|--------|--------|----|--------|--------|
| Total  | 5.3409 | 33 |        |        |
| Nets   | 0.0470 | 1  | 0.0470 | 1.03   |
| Days   | 4.5642 | 16 | 0.2852 | 6.25** |
| Error  | 0.7297 | 16 | 0.0456 |        |

\*\*P<0.01

**Table 7g.** *Anova of prawns and lobsters (40-55m)*

| Source | ss     | df | ms     | f       |
|--------|--------|----|--------|---------|
| Total  | 0.9837 | 33 |        |         |
| Nets   | 0.0284 | 1  | 0.0284 | 24.70** |
| Days   | 0.7710 | 16 | 0.0481 | 4.18**  |
| Error  | 0.1843 | 16 | 0.0115 |         |

|            |                    |                |
|------------|--------------------|----------------|
| Mean catch | Bulged belly trawl | Six seam trawl |
| Log units  | 0.1629             | 0.1051         |
| Actual kg  | 1. 455             | 1. 274         |

\*\*P<0.01

**Table 7h.** *Anova of miscellaneous fishes (40-55m)*

| Source | ss      | df | ms     | f      |
|--------|---------|----|--------|--------|
| Total  | 10.1297 | 33 |        |        |
| Nets   | 0.0365  | 1  | 0.0365 | 0.27   |
| Days   | 7.9392  | 16 | 0.4962 | 3.69** |
| Error  | 2.1540  | 16 | 0.1346 |        |

\*\*P &lt; 0.01

---

**References**

- Benyami, M. (1959) *Modern Fishing Gear of the World* (Kristjonsson, H., Ed.) p. 213, Fishing News (Books) Ltd., London
- Deshpande, S.D. (1960) *Indian J. Fish.* **7**, 458
- Deshpande, S.D., Rama Rao, S.V.S. & Vijayan, V. (1970) *Fish. Technol.* **7**, 186
- Kuriyan, G.K., Satyanarayana, A.V.V. & Nair, R.S. (1964) *Proc. Indo-Pacif. Fish. Coun.* **11**, 204
- Pillay, N.S., Vijayan, V., Hridayanathan, C. & Manoharadoss, R. S. (1978) *Fish. Technol.* **15**, 71
- Satyanarayana, A.V.V. & Nair, R.S. (1965) *Res. & Ind.* **10**, 229
- Varghese, C.P., Vijayan, V. & Kuriyan, G.K. (1968) *Fish. Technol.* **5**, 9



## Evolution of Suitable Net for Medium Sized Vessels-ii Introduction of Large Meshed High Opening Fish Trawl

N. SUBRAMONIA PILLAI, N. A. GEORGE AND A. K. KESAVAN NAIR  
*Central Institute of Fisheries Technology, Cochin-682029*

Large meshed high opening trawl was found to be very efficient for the exploitation of column and off bottom fishes. The net is found more efficient than the bulged belly trawl in capturing different varieties of column fishes comprising of squids, pomfrets, barracudas, cat fishes, sharks and rays. The net offers 18% lesser resistance which in turn results in utilization of lesser horse power. The trawl is very simple in construction and requires minimum maintenance because of reduced number of meshes. The total cost of the net is less by 35% as the larger mesh size reduces the material requirement and cost of fabrication.

The development of fishing industry in India was centred around the development of shrimp fishing in the past, whereas no inroads have been made for the exploitation of the vast untapped resources of different column fishes, excepting the traditional exploitation of sardines and mackerels. There being no trawl gear exclusively for fish, the demersal fishes were caught while trawling for prawns. The introduction of bulged belly trawl has improved the catch of fish in addition to shrimp because of higher vertical opening developed by the net (Varghese & Kuriyan, 1968; Pillai *et al.*, 1978). In this communication the authors report their attempts to develop a high opening trawl with larger meshes and increased height to catch column and demersal fishes.

High opening trawl is a recent introduction (Buckingham, 1972) and is found very successful and efficient. The present trend in trawl design is to use larger meshes, as the schooling fishes seldom attempt to escape through the large meshes of the fore-part of the net. The advantages of larger meshes have been already reported by Johnson (1971) and Scott (1974). The increase in mesh size has greatly improved the catching efficiency of the net. In India so far, no published work is available on large meshed trawls and hence the present investigation was initiated.

### Materials and Methods

A large sized mesh trawl with 32 m head rope and high opening was designed and fabricated as specified in Fig. 1 and Table 1. The mesh size has been increased from 50% in the cod-end to 100% through the fore-part of the net when compared to the conventional trawl. Because of the increase in mesh size the total number of meshes has been reduced to 120% and webbing to 35% compared to a 32 m bulged belly trawl described by Pillai *et al.* (1978).

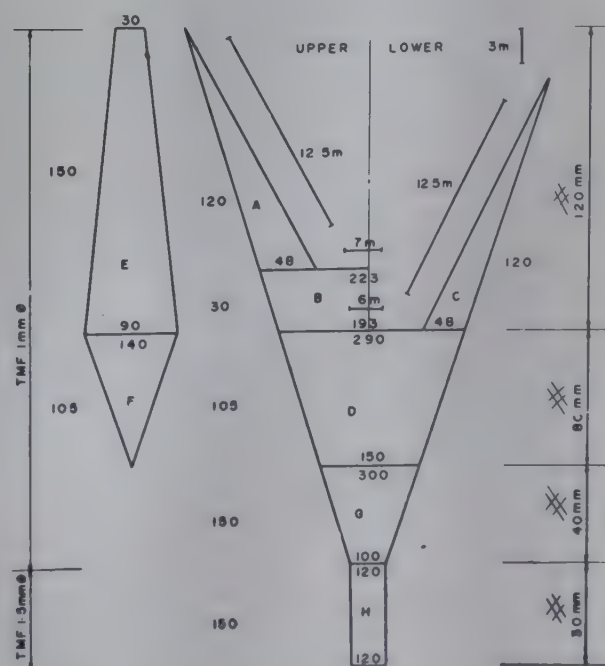


Fig. 1. 32m large meshed high opening trawl

Comparative details of the large meshed trawl and a bulged belly trawl are presented in Table 2.

Regular fishing was carried out from the CIFT vessel-Sindhukumari-15.2 m OAL fitted with a 165 HP Cummins engine during two fishing seasons at depths of 27 to 37 m off Cochin. The large meshed trawl was operated together with a 32 m bulged belly trawl to compare the effect of increased mesh size. Otter boards of 1900 x 900 mm flat rectangular wooden described by Pillai *et al.* (1978) have been used. The nets were operated one after another keeping depth, length of rope, trawling speed and duration of haul constant. The quantity of different varieties of fish caught by both the nets was recorded separately. The horizontal opening between otter boards was measured by an angle measurer and the warp tension by an electronic warp load tension meter (Sivadas, 1978).

## Results and Discussion

The details of fishing and catch composition of different varieties of fishes in respect to both nets are presented in Table 3.

Total of 22245 kg of fish was landed by both the nets, of which 58% was contributed by the large meshed high opening trawl. *Synagris* and sciaenids which are mainly benthic, constituted the major portion of the catch (85%) and the catching rate was 56% and 44% for large meshed trawl and bulged belly trawl respectively, showing 12% more for large meshed trawl, while in the case of sharks, rays and other varieties such as squids and cuttle fishes, barracudas, cat fish and pomfrets which are predominantly column fishes the percentage was 30-46 more for large meshed trawl. 75% of the total prawn catch was landed by the bulged belly thereby showing its efficiency over large meshed trawl. So it is clear from the catch that large meshed trawl is more efficient for all varieties of fishes and squids.

The analysis of the composition of catch of the two nets at the two different depths also showed some marked difference. Below 30 m the comparative catch rate of the two nets was 52% for large meshed

trawl and 48% for bulged belly trawl and the catch per hour for large meshed trawl and bulged belly trawl was 86.5 kg and 82.6 kg respectively. So it is clear that there is not much difference in the catch rate and both nets show almost equal efficiency in this depth range. At 30 m and beyond the catch rate for large meshed trawl and bulged belly trawl was 59 and 41% respectively, showing a difference of 18% and the catch per hour for the two nets was 157 kg and 107 kg respectively indicating significant difference between the nets. Thus large meshed trawl was found to be more efficient in deeper waters beyond 30 m. It was also observed that in both the depth ranges the catch rate of column fishes in the large meshed trawl was almost double than that of the bulged belly trawl. This was due to the fact that large meshed trawl developed more vertical opening than bulged belly trawl.

Another interesting finding was that all the squids and cuttle fishes were caught beyond 30 m and a total of 880 kg was landed by the two nets, of which 580 kg of squids were accounted by large meshed trawl being 93% more when compared to the squid and cuttle fish caught by the bulged trawl. As squids and cuttle fish are important items of export its exploitation assumes greater importance. The large meshed trawl can be successfully operated for the exploitation of the vast resources of squids and cuttle fish in the seas around India.

The data were statistically analysed separately for total fish, squids, sharks and rays as these varieties constituted major items of catch and as also they are commercially important. The mean catches of the two nets were compared by analysis of variance technique. Analysis of variance of total fish catch after converting the data to logarithmic scale to stabilize the variance is presented in Table 4. The difference between the mean catches was found to be highly significant showing large meshed high opening trawl to be more efficient with respect to total fish catch. The catch of squids and cuttle fishes were converted to logarithmic scale after adding unity to each observation to tackle 'o' observations. The analysis of variance is presented in Tables 5 and 6.



Table 1. Details of 32m large meshed high opening trawl

|                        |        |       |        |       |       |       |       |       |
|------------------------|--------|-------|--------|-------|-------|-------|-------|-------|
| Webbing                | A      | B     | C      | D     | E     | F     | G     | H     |
| Stretched mesh mm      | 120    | 120   | 120    | 80    | 120   | 80    | 40    | 30    |
| Upper edge meshes      | 1      | 223   | 1      | 290   | 30    | 140   | 300   | 130   |
| Lower edge meshes      | 48     | 193   | 48     | 150   | 90    | 1     | 100   | 130   |
| Depth meshes           | 120    | 30    | 120    | 105   | 150   | 105   | 150   | 150   |
| No. of pieces          | 2      | 1     | 2      | 2     | 2     | 2     | 2     | 2     |
| Cutting rate           | 1p 3b  | 1p 2b | 1p 3b  | 1p 4b | 2p 1b | 1p 4b | 1p 4b | All p |
| Baiting rate           | ...    | 1:2   | ...    | 1:1.5 | 1:5   | 1:1.5 | 1:1.5 | ...   |
| Rope length m          | a 12.5 | b 7.0 | c 12.5 | d 6.0 | e 3.0 |       |       |       |
| Hanging co-efficient % | 87     | 45    | 87     | 50    | 80    |       |       |       |

Table 2. Particulars of large meshed trawl and bulged belly trawl

| Particulars          |    | Large meshed<br>high opening trawl | Bulged belly trawl |
|----------------------|----|------------------------------------|--------------------|
| Head rope length     | m  | 32                                 | 32                 |
| Foot rope length     | m  | 37                                 | 35                 |
| Wing mesh size       | mm | 150                                | 80                 |
| Jib mesh size        | mm | 120                                | 60                 |
| Overhang mesh size   | mm | 120                                | 60                 |
| Body mesh size       | mm | 80                                 | 50                 |
|                      |    | 40                                 | 40                 |
|                      |    |                                    | 30                 |
|                      |    |                                    | 20                 |
| Cod-end mesh size    | mm | 30                                 |                    |
| No. of meshes        |    | 1,96,000                           | 4,10,000           |
| Twine size           |    | 1 mm dia                           | 1 mm dia           |
|                      |    | 1.5 mm dia                         | 1.5 mm dia         |
| Material requirement |    | 18.5 kg                            | 29 kg              |

Table 3. Catch composition of fishes caught by large meshed high opening trawl and bulged belly trawl

| Fishing season              | Depth of operation | Trawling hours | Type of net        | Quantity of fish caught (kg) |                        |                                    |             |          |                |                         | Total | Catch/h |
|-----------------------------|--------------------|----------------|--------------------|------------------------------|------------------------|------------------------------------|-------------|----------|----------------|-------------------------|-------|---------|
|                             |                    |                |                    | Prawn                        | Squids and cuttle fish | Pomfr-ets and other quality fishes | Barra-cuda  | Cat fish | Shark and rays | Syna-gris and sciaenids |       |         |
| 1977-1978                   | Up to 30 m         | 33             | Large meshed trawl | 16                           | —                      | 19                                 | 21          | 56       | 37             | 2706                    | 2855  | 86.5    |
|                             |                    | 33             | Bulged belly trawl | 45                           | —                      | 8                                  | 12          | 25       | 20             | 2620                    | 2730  | 82.6    |
| 1978-1979                   | Beyond 30 m        | 63             | Large meshed trawl | 0                            | 580                    | 31                                 | 164         | 25       | 1131           | 7954                    | 9885  | 157.0   |
|                             |                    | 63             | Bulged belly trawl | 3                            | 300                    | 10                                 | 61          | 15       | 606            | 5780                    | 6775  | 107.0   |
| Total and % for two seasons |                    | 96             | Large meshed trawl | 16 (25%)                     | 580 (65.7%)            | 50 (73.2%)                         | 185 (71.7%) | 81 (67%) | 1168 (65%)     | 10650 (56%)             | 12740 | (58%)   |
|                             |                    | 96             | Bulged belly trawl | 48 (75%)                     | 300 (34.3%)            | 18 (26.8%)                         | 73 (28.3%)  | 40 (33%) | 626 (35%)      | 8400 (44%)              | 9505  | (42%)   |
| Total catch                 |                    |                |                    | 64                           | 880                    | 68                                 | 258         | 121      | 1794           | 19050                   | 22245 |         |

**Table 4.** *Analysis of variance of total catch*

| Source        | ss      | df | ms       |
|---------------|---------|----|----------|
| Total         | 3.79078 | 77 |          |
| Between gears | 0.48258 | 1  | 0.48258* |
| Between days  | 3.09757 | 38 | 0.08151* |
| Error         | 0.21064 | 38 | 0.00554  |

Mean catch (logarithmic scale) for large meshed trawl 2.3025 and bulged belly trawl 2.1452

\* Highly significant ( $p < 0.001$ )

**Table 5.** *Analysis of variance for squids and cuttle fish*

| Source        | ss       | df | ms       |
|---------------|----------|----|----------|
| Total         | 10.10413 | 61 |          |
| Between gears | 1.23615  | 1  | 1.23615* |
| Between days  | 8.67058  | 35 | 0.24773* |
| Error         | 0.19741  | 35 | 0.00564  |

Mean catch (logarithmic scale) for large meshed trawl 1.1015 and bulged belly trawl 0.8395

\* Highly significant ( $p < 0.001$ )

**Table 6.** *Analysis of variance for sharks and rays*

| Source        | ss      | df | ms       |
|---------------|---------|----|----------|
| Total         | 7.05858 | 61 |          |
| Between gears | 1.01596 | 1  | 1.01596* |
| Between days  | 5.26577 | 30 | 0.17553* |
| Error         | 0.77685 | 30 | 0.02589  |

Mean catch (logarithmic scale) for large meshed trawl 1.4243 and bulged belly trawl 1.1683

\* Highly significant ( $p < 0.001$ )

**Table 7.** *Average horizontal spread between otter boards and average tension for the two nets*

| Net                             | Depth of operation<br>m | Average speed<br>knots | rpm          | Average tension<br>kg | Average horizontal opening<br>m |
|---------------------------------|-------------------------|------------------------|--------------|-----------------------|---------------------------------|
| Large meshed high opening trawl | 27 to 37                | 3                      | 1200 to 1250 | 450                   | 30                              |
| Bulged belly trawl              | 27 to 37                | 3                      | 1300 to 1350 | 550                   | 28                              |



The difference between the mean catches of the gears was found highly significant showing the large meshed high opening trawl to be more efficient than the bulged belly trawl. The difference between the mean catches of the gear was found to be highly significant and the large meshed trawl was more efficient than the bulged belly.

Based on the composition of catch in the large meshed trawl, it can be reasonably inferred that the better efficiency of this net is due to the higher vertical opening and horizontal spread. This is because of the special type of jib with more length and a short side seam with more vertical height, which enables the net to develop a wider mouth opening to catch more fish in the column water, in addition to the bottom fishes. It is possible that the larger meshes in the fore part allow more flow of water and the fishes that enter the net have to swim faster to escape through the meshes. Naturally fishes take the easier way and swim to the cod-end and get caught.

The average horizontal spread between otter boards, the average tension offered by the nets and rpm of engine are tabulated in Table 7.

The resistance of large meshed trawl is 18% lesser than that of bulged belly trawl thereby indicating lesser horse power for towing the large meshed trawl. This is evident from the fact that the large meshed trawl requires an average rpm of 1200 to 1250 for a trawling speed of three knots, whereas the bulged belly trawl requires 1300 to 1350 rpm for the same speed. The lesser resistance by the large meshed trawl is due to the larger meshes which allow more flow of water thereby reducing the tension considerably and also reduction in total weight of the net owing to fewer meshes. The use of larger mesh for reduced towing resistance has been already reported by Rehme (1973). Fig. 2 gives a clear picture of the comparative efficiency between the two nets. The use of large meshed high opening trawl has indicated an increased

efficiency of 95% and 27% respectively for column and demersal fishes and 18% lesser resistance and comparatively wider mouth opening. The reduction in the resistance of the net indicates lesser utilisation of power and this enables further scope for using bigger nets with the same engine. Above all, the cost of the

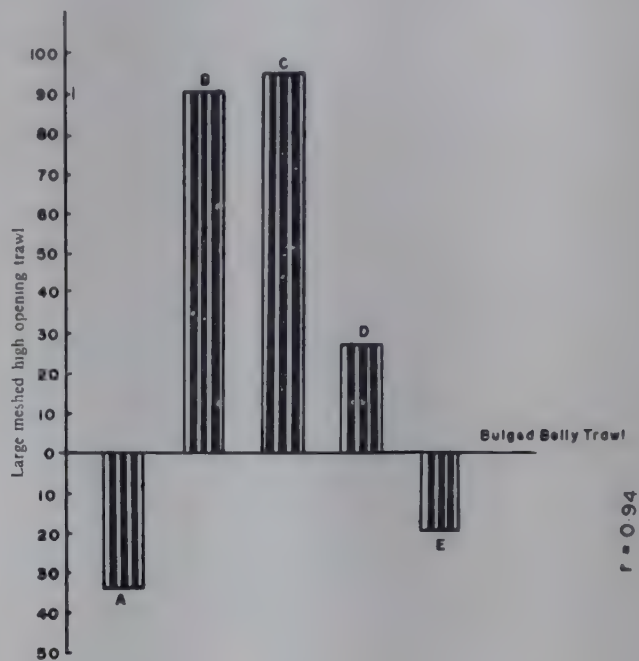


Fig. 2. Comparative efficiency of large meshed high opening trawl and bulged belly trawl A-Decrease in cost; B-Increase in squid catch; C-Increase in column fish; D-Increase in demersal fish; E-Decrease in resistance.

net can also be reduced to 35%. Further it is also observed that this net caught bigger sized fishes, allowing the small ones to escape through the bigger meshes of the codend, thereby helping in the conservation of species. The use of small meshes for the trawl net which filter small fishes should be discouraged and the mesh size could be further increased for more efficiency and better catch.

The authors are grateful to Shri G. K. Kuriyan Director, Central Institute of Fisheries Technology for his guidance and permission to publish this paper and to Shri R. Balasubramanian and Shri P. A. Panicker, Scientists for their suggestions and modification of the manuscript. They are also indebted to the skipper and crew of M. F. V. Sindhukumari for their assistance in fishing.

**References**

- Buckingham, H. (1972) *Wld Fishg.* **21**, 55
- Johnson, W.W. (1971) *Can. Fisherm.* **57**, 35
- Rehme, W. (1973) *Wld Fishg.* **22**, 70
- Scott, W.J. (1974) *Aust. Fisheries.* **33**, 33
- Sivadas, T.K. (1978) *Fish. Technol.* **15**, 68
- Pillai, N.S., Vijayan, V. & Hridayanathan, C. (1978) *Fish. Technol.* **15**, 71
- Varghese, C.P. & Kuriyan, G.K. (1968) *Fish. Technol.* **5**, 9



## Protein Hydrolysate from Miscellaneous Fish

R. THANKAMMA, K. GOPAKUMAR, A. LEKSHMY NAIR,  
A. VASANTH SHENOY AND M. ARUL JAMES

*Central Institute of Fisheries Technology, Cochin-682 029*

A method to prepare fish protein hydrolysate from miscellaneous fish obtained as by catch from shrimp trawlers is outlined. Effect of temperature and concentration of enzyme papain on the yield of hydrolysates has been determined. It is seen that within 30 min at 55°C and pH 6.5 fish proteins can be effectively solubilised, provided the nitrogen content of the enzyme (activity 10 units/mg enzyme) and substrate are maintained in the ratio 1:30. This hydrolysate possesses the best amino acid pattern compared to those obtained after hydrolysis for 60 to 180 min.

Miscellaneous fish constitute a major portion of the fish catch. At present they are not utilised fully and some attempts have been made to utilise them (Anon, 1973, '76, '77, '78). Protein hydrolysate from miscellaneous fish (trash fish) has several commercial applications. Dietary protein is absorbed in the form of oligo peptides and free amino acids. Protein hydrolysates which contain oligo peptides and free amino acids have better physiological advantages in correcting malnutrition compared to a mixture of free amino acids (Mathews, 1971; Silk, 1974).

Fish protein has been used as raw material for the production of hydrolysates by many workers. The factors affecting the degree of hydrolysis and the fractional analysis of certain papaic hydrolysates of fish flesh have been reported by Sen *et al.* (1962) and Sripathy *et al.* (1962). Sripathy *et al.* (1963) showed that fish hydrolysates are of good nutritional value. Technological aspects relating to the production of hydrolysate from a fresh water fish, *Barbus dubius* using papain have been worked out by Sripathy *et al.* (1964). Hale (1969) measured the relative activities of more than twenty commercially available proteolytic enzymes for the digestion of a washed and freeze-dried fish protein substrate and showed that pepsin, papain and pancreatin all combined good activity with moderate cost. Hale (1972) has also reported effects of various processing conditions and commercially available proteolytic enzymes on yield and composition

of water soluble fish protein hydrolysates. According to McBride *et al.* (1961) pepsin produced better solubilization of herring tissue than other proteolytic enzymes. Yanez *et al.* (1976) employed hake as raw material for the production of protein hydrolysates and used it for the supplementation of cereal protein. However, one of the disadvantages of protein hydrolysate is its bitterness, caused by the presence of bitter peptides. Recently, Lalasidis *et al.* (1978) and Lalasidis & Sjoberg (1978) used a powerful bacterial endopeptidase alcalase, followed by pancreatin to produce bitter-free protein hydrolysate from deboned cod filleting offal, fish protein concentrate and fresh herring. Both pepsin and papain were initially tried to produce hydrolysates by the authors. Subsequently pepsin was discontinued from the studies as it involved hydrolysis at a lower pH, which necessitated the neutralisation of the final product thereby increasing concentration of salt in the finished product. The physical properties of peanut flour hydrolysed by bromelin, pepsin and trypsin have been reported by Beuchat *et al.* (1975), but pepsin and trypsin are too expensive for commercial applications. Papain is reported to be more desirable in proteolysis than bromelin (Sekul & Ory, 1977). Sekul *et al.* (1978) also showed that proteolysis of peanut proteins with papain caused certain functional changes in the properties of hydrolysed proteins with certain advantages in food applications. The present study reports the effect of temperature, time and concentration of

enzyme on the yield of protein hydrolysate from miscellaneous fish.

## Materials and Methods

Miscellaneous fish were obtained from shrimp trawlers operated off Cochin. Commercial grade papain (activity 10 units/mg enzyme) was employed. Quantity of the enzyme required to hydrolyse fish proteins was calculated in terms of the ratios of the nitrogen contents of both enzyme and substrate, following the method of Nanda *et al.* (1977). The quantity of minced fish meat used varied from 1–15 kg.

The comminuted whole fish and picked fish meat were separately mixed with 1:1 w/w of water, sterilized at 0.7 kg/sq cm pressure for 30 min and cooled. The pH was adjusted to 6.5 with hydrochloric acid and transferred to a reaction vessel maintained at different temperatures with the help of a thermostatic water bath. At these temperatures the required quantity of enzyme dissolved in minimum quantity of distilled water was added and the reaction mixture stirred continuously. After specific intervals of time varying from 15 to 180

min the reaction was stopped by boiling the contents, filtered through Whatman No. 1 filter paper and the hydrolysate separated, pH adjusted to 7, concentrated on a water bath and dried under vacuum. The amino acid composition of the protein hydrolysates prepared from threadfin bream was estimated by microbiological assay methods of Kavanagh (1963).

## Results and Discussion

Yield of protein hydrolysates at different concentrations of enzyme is given in Table 1. The effect of time and temperature on the yield of hydrolysate is presented in Tables 2 and 3. Table 4 gives the amino acid composition of protein hydrolysates prepared from threadfin bream hydrolysed for different periods using same concentration of enzyme (enzyme nitrogen to substrate nitrogen ratio 1:30). Yields of protein hydrolysates from different species of trash fish are given in Table 5.

Table 1 shows that among the different concentrations of papain used to hydrolyse fish proteins the optimum yield is obtained when enzyme and substrate

**Table 1.** Yield\* of fish protein hydrolysate with respect to change in enzyme (papain) concentration (pH 6.5, temperature 55°C and time 180 min)

| Fish                             | Ratio of enzyme nitrogen to substrate nitrogen |      |      |      |
|----------------------------------|------------------------------------------------|------|------|------|
|                                  | 1:20                                           | 1:30 | 1:40 | 1:60 |
| Threadfin bream (whole) Sample 1 | 12.4                                           | 11.3 | 8.9  | 7.3  |
| Sample 2                         | 12.1                                           | 11.0 | 10.2 | 10.2 |
| Threadfin bream meat (picked)    | 7.9                                            | 7.8  | 7.4  | 7.1  |
| Jew fish (whole)                 | 8.9                                            | 8.0  | 6.1  | 5.3  |

\* g/100 g whole fish/picked meat

**Table 2.** Yield\* of fish protein hydrolysate with respect to time of hydrolysis (enzyme nitrogen to substrate nitrogen ratio 1:30, pH 6.5, temperature 55°C)

| Fish                             | Time in min |      |      |      |      |
|----------------------------------|-------------|------|------|------|------|
|                                  | 15          | 30   | 60   | 120  | 180  |
| Threadfin bream (whole) Sample 1 | 8.8         | 10.2 | 10.2 | 10.5 | 10.6 |
| Sample 2                         | 10.9        | 11.4 | 11.5 | 12.2 | 12.2 |
| Threadfin bream meat (picked)    | 9.0         | 9.6  | 10.0 | 10.2 | 10.0 |
| Sole (whole)                     | 11.2        | 11.8 | 11.8 | 12.3 | 12.3 |
| Glassy perchlet (whole)          | 10.0        | 10.7 | 10.8 | 11.2 | 11.3 |

\* g/100g whole fish/picked meat



**Table 3.** *Effect of temperature on hydrolysis of minced whole fish*  
(enzyme nitrogen to substrate nitrogen ratio 1:30, pH 6.5, time of hydrolysis 30 min)

| Sample | Yield * of hydrolysate at |      |      |      |      |
|--------|---------------------------|------|------|------|------|
|        | 40°C                      | 50°C | 55°C | 60°C | 70°C |
| 1      | 9.0                       | 10.8 | 11.3 | 10.7 | 10.0 |
| 2      | 10.7                      | 11.5 | 12.9 | 11.3 | 10.7 |
| 3      | 10.5                      | 12.2 | 12.8 | 12.4 | 12.3 |
| 4      | 8.7                       | 8.8  | 11.1 | 9.3  | 8.9  |

\* g/100g whole fish

**Table 4.** *Amino acid composition of protein hydrolysates at different times of hydrolysis*  
(enzyme nitrogen to substrate nitrogen ratio 1:30, pH 6.5, temperature 55°C)

| Amino acids*  | Hydrolysate |        |         |         |
|---------------|-------------|--------|---------|---------|
|               | 30 min      | 60 min | 120 min | 180 min |
| Lysine        | 7.32        | 8.34   | 7.10    | 7.92    |
| Methionine    | 2.67        | 2.54   | 2.71    | 3.20    |
| Leucine       | 3.03        | 2.14   | 3.16    | 3.21    |
| Isoleucine    | 2.36        | 3.14   | 3.43    | 3.11    |
| Threonine     | 5.11        | 4.96   | 4.93    | 4.87    |
| Tryptophan    | 0.99        | 0.89   | 0.79    | 0.84    |
| Phenylalanine | 4.43        | 4.39   | 4.41    | 4.06    |
| Valine        | 2.26        | 1.96   | 2.43    | 2.37    |
| Arginine      | 4.25        | 5.31   | 5.52    | 5.67    |
| Glutamic acid | 10.51       | 13.56  | 13.60   | 13.41   |
| Aspartic acid | 4.62        | 4.91   | 5.26    | 5.71    |
| Histidine     | 2.51        | 3.91   | 5.73    | 4.97    |
| Glycine       | 2.50        | 2.91   | 2.46    | 2.62    |
| Serine        | 4.75        | 5.25   | 4.95    | 4.31    |
| Proline       | 3.61        | 4.66   | 4.21    | 3.95    |
| Cystine       | 0.47        | 0.63   | 0.62    | 0.69    |
| Tyrosine      | 4.81        | 5.24   | 5.40    | 5.16    |

\* g/100g protein

nitrogen were in the ratio 1:30. Using this ratio, the effect of reaction time on proteolysis was worked out (Table 2). Though maximum yield of hydrolysate was obtained when hydrolysis extended up to 180 min the differences in yield was not appreciable compared to that at 30 min. Further reduction in time of hydrolysis to 15 min entailed in certain cases appreciable lowering in the yield of hydrolysate, suggesting that a viable yield could be obtained after 30 min hydrolysis.

The study of the effect of temperature on proteolysis of fish proteins with enzyme

papain shows that (Table 3) an operational temperature of 55°C will be the most suitable for the maximum yield of hydrolysate.

The study of the overall amino acid pattern of the different hydrolysates produced at 30, 60, 120 and 180 min showed very little variation in the individual amino acid make up. However, it should be noted that tryptophan, phenylalanine and threonine are lost significantly when hydrolysis was extended to 180 min. Glycine, proline, leucine and valine showed very little change between 30 and 180 min. The rest of the amino acids showed a

**Table 5.** *Yield of protein hydrolysate from miscellaneous fish (enzyme nitrogen to substrate nitrogen ratio 1:30, pH 6.5, temperature 55°C, time of hydrolysis 30 min).*

| Common name            | Species name                      | Yield* of hydrolysate |
|------------------------|-----------------------------------|-----------------------|
| Lizard fish            | <i>Saurida tumbil</i>             | 13.3                  |
| Large spined flat head | <i>Platycephalus macracanthus</i> | 11.0                  |
| Ribbon fish            | <i>Trichiurus</i> sp.             | 9.9                   |
| Barracuda              | <i>Sphyræna</i> sp.               | 11.9                  |
| Jew fish               | <i>Johnius</i> sp.                | 9.9                   |
| Threadfin bream        | <i>Nemipterus japonicus</i>       | 12.0                  |
| Cat fish               | <i>Tachysurus</i> sp.             | 10.9                  |
| Anchovies              | <i>Thrissoles</i> sp.             | 9.7                   |
| Sole                   | <i>Cynoglossus</i> sp.            | 8.6                   |

\* g/100g whole fish

marginal increase. Considering the loss of tryptophan, phenylalanine and threonine (essential amino acids) it is not advisable to carry out hydrolysis up to 180 min from the nutritional point, as they will become limiting amino acids when protein scores are evaluated to incorporate hydrolysates in food preparations. It is also reported that extended enzymatic digestion of fish proteins causes a reduction of their nutritional value and a partial destruction of essential amino acids (Gillies, 1975). Thus the best amino acid pattern is obtained in the product after 30 min hydrolysis.

Picked fish meat, obtained with the help of a mechanical flesh separator, which removes bones, scales and skin from meat, invariably gave lower yield compared to whole fish meat. The higher yield of hydrolysates from whole fish can be interpreted as due to the presence of calcium ions in the meat, obtained from bones, which is found to activate papain.

The authors are indebted to Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology and Shri M. Rajendranathan Nair, Project Co-ordinator for permission to publish the paper.

## References

Anon (1973) *Proc. ii Workshop, Indian Council of Agricultural Research Co-ordinated Research Project on Transportation of Fresh Fish and Utilization of*

*Trash Fish.* Mangalore, April 5-8 (unpublished)

Anon (1976) *Proc. IV Workshop, Indian Council of Agricultural Research Co-ordinated Research Project on Transportation of Fresh Fish and Utilization of Trash Fish.* Cochin, October 27-28 (unpublished)

Anon (1977) *Proc. V Workshop, Indian Council of Agricultural Research Co-ordinated Research Project on Transportation of Fresh Fish and Utilization of Trash Fish.* Madras, November 15-16 (unpublished)

Anon (1978) *Proc. VI Workshop, Indian Council of Agricultural Research Co-ordinated Research Project on Transportation of Fresh Fish and Utilization of Trash Fish.* Mangalore, November 3-4 (unpublished)

Beuchat, L.R., Cherry, J.P. & Quinn, M.R. (1975) *J. agric. Fd chem.* **23**, 616

Gillies, M. T. (1975) *Fd Technol. Rev.* **22**, 313

Hale, M.B. (1969) *Fd Technol.* **23**, 107

Hale, M.B. (1972) *NOAA Technical Report NMFS SSRD 657, Making Fish Protein Concentrates by Enzymatic Hydrolysis*



- Kavanagh, F. (1963) *In Analytical Microbiology*, 1st edn., p. 167, Academic press, New York
- Lalasidis, G., Bostrom, S. & Sjoberg, L.B. (1978) *J. agric. Fd chem.* **26**, 751
- Lalasidis, G. & Sjoberg, L.B. (1978) *J. agric. Fd chem.* **26**, 742
- Mathews, D.M. (1971) *J. Clin. Pathol.* **24**, Suppl. (Roy. Coll. Path) **5**, 29
- McBride, J.R., Idler, D.R. & Macleod, R.A. (1961) *J. Fish. Res. Bd Can.* **18**, 93
- Nanda, C.L., Ternmouth, J.H. & Kondas, A.C. (1977) *J. Sci. Fd Agric.* **28**, 20
- Sekul, A.A. & Ory, R.L. (1977) *J. Am. Oil chem. Soc.* **54**, 32
- Sekul, A.A., Vinnet, C.H. & Ory, R.L. (1978) *J. agric. Fd chem.* **26**, 855
- Sen, D.P., Sripathy, N.V., Lahiry, N.L., Sreenivasan, A. & Subramanyam, V. (1962) *Fd Technol.* **16**, 138
- Silk, D.B.D. (1974) *Gut.* **15**, 494
- Sripathy, N.V., Sen, D.P., Lahiry, N.L., Sreenivasan, A. & Subramanyam, V. (1962) *Fd Technol.* **16**, 141
- Sripathy, N.V., Kadkol, S.B., Sen, D.P., Swaminathan, M. & Lahiry, N.L. (1963) *J. Fd Sci.* **28**, 365
- Sripathy, N.V., Sen, D.P. & Lahiry, N.L. (1964) *Res. & Ind.* **9**, 258
- Yanez, E., Ballester, D. & Monckeberg, F. (1976) *J. Fd Sci.* **41**, 1289





## Red and White Meat of Tuna (*Euthynnus affinis*): Their Biochemical Role and Nutritional Quality

M. K. MUKUNDAN, M. ARUL JAMES, A. G. RADHAKRISHNAN  
AND P. D. ANTONY

Central Institute of Fisheries Technology, Cochin-682029.

The biochemical and nutrient compositions of red and white meat of tuna are reported. Based on the data the biochemical role and nutritional quality of red and white meat are discussed. The results show that red meat is adapted for slow and continuous activity and white meat for quick but occasional activity. In spite of comparatively low lysine content the red meat is adjudged more nutritious than white meat.

Tuna is an important food fish. Out of the total world fish catch of 70 million tons, 1.5 million tons are composed of tuna, belonging to about 12 species (Anon, 1975). Substantial quantities of tuna are canned, a part is processed to conventional cured products like 'massmin' and the rest is consumed fresh. Generally tuna meat is considered highly nutritive owing to its content of essential amino acids, protein and fat (Chinnamma, 1975). Probably this is why tuna is nicknamed chicken of the sea.

Like majority of the fish, tuna too is composed of red and white meat, a characteristic trait of fish capable of continuous swimming, where the red muscle is supposed to play an important role in muscular activity (Anon, 1966). However, the proportion of red meat in tuna is very high forming about 11% (Chinnamma, 1975). In the case of certain species of tuna the red meat content is low while in some other species like mackerel tuna (*Euthynnus affinis*) it is still higher. In tuna canning, only the white meat is used discarding considerable quantities of red meat as waste, which is often converted to poultry and animal feeds.

The wastage of red meat, a valuable food has prompted a rethinking among food scientists as evidenced by the numerous studies on red and white meat of tuna and other fishes, though most of them are biochemical in nature rather than nutritional. Thus the distribution of histidine (Amano & Bito, 1951), cytochrome C and myoglobin

(Matsura & Hashimoto, 1954), major chemical constituents and vitamins (Breakken, 1956), cholesterol and long chain polyenoic acids (Igarashi *et al.*, 1957) and biochemical constituents (Chinnamma, 1975) in red and white meat of different species of tuna were reported. Similar studies on red and white meat were conducted in mackerel (*Scomber scombrus*) (Breakken, 1959; Nagayama, 1961), mackerel (*Rastrelliger kanagurta*) (George, 1962) and sardine (*Sardinella longiceps*) (Watabe *et al.*, 1977). In spite of all their data, a critical study of the red and white meat from the nutritional point of view does not appear to have been made.

The present study reveals the difference between red and white meat of tuna with respect to their biochemical and nutritional character.

### Materials and Methods

Fresh tuna weighing 4 to 5 kg each obtained from local market were gutted and kept in chilled storage before use. In any case the storage never exceeded 24 h. The red and white meat from the central region (between the two dorsal fins) were separated, minced and used. All chemicals employed were of pure or analar grade.

Moisture and ash were determined as described in AOAC (1970). Fat was estimated according to Bligh & Dyer (1959). The ash obtained above was dissolved in normal hydrochloric acid and was used for the determination of sodium, potassium

and calcium (Vogel, 1960) and iron (Lawrence 1960). For protein estimation, about 100 mg dry muscle was digested with concentrated sulphuric acid and a pinch of digestion mixture and its nitrogen content estimated according to microkjeldahl method (Hawk, 1954). From the total nitrogen so obtained the non-protein nitrogen was deducted and the result multiplied by 6.25 to give the protein content.

Glycogen was estimated in the wet tissue using the method of Schwartz & Rall (1973). Trichloroacetic acid extracts of the tissue were prepared according to Umbriet *et al.* (1959) which were used for the estimation of reducing sugar (Folin & Malmros, 1929), inorganic phosphate (Fiske & Subbarow, 1925), non-protein nitrogen (Hawk, 1954) and lactic acid (Barker & Summerson, 1941).

Sarcoplasmic proteins were extracted according to Paul *et al.* (1966) using pH 7.5 borate buffer and electrophorised in polyacrylamide gel columns as described by Ornstein & Davis (1964).

Amino acid composition was determined by the standard microbiological assay (Kavanagh, 1963). All colourimetric measurements were done in Spectronic-20 (Bosh and Lomb) and the flame photometric measurements in a flame photometer (Systronics Instruments).

## Results and Discussion

The percentage of fat, protein, carbohydrate, moisture and the computed calorific values for red and white meat of

tuna along with that of hen's egg (whole) and fresh tuna liver tissues are shown in Table 1. The data show a clear difference between red and white meat in their carbohydrate and fat contents which are significantly more in red meat. The threefold occurrence of carbohydrate in red meat compared to white meat as also reported by Breakken (1959) and Chinnamma (1975) along with the higher percentage of fat shows the role of red muscle as a storage and regulatory organ like liver (White *et al.*, 1973) in mammals. This view is further supported by the reports that red muscle contains more of the enzyme systems like arginase (Matsura *et al.*, 1953), cytochrome C (Matsura & Hashimoto, 1954), phosphatase and phosphorylase (Ogata & Mori, 1963). The only difference of liver from red meat, is its high carbohydrate content, the differences in protein contents among red meat, white meat and liver being negligible. However, egg displays a peculiar composition characterised by high fat and moisture contents and low protein value.

The calorific values computed also show that red meat has more food value than white meat. The reports on the higher concentrations of vitamins like pantothenic acid, riboflavin, thiamine and cyanocobalamine (Breakken, 1959) and vitamin A (Higashi, 1961) in red meat of tuna also show that it is more nutritious than white meat. The only vitamin reported to occur in large quantities in white meat of tuna is niacin (Breakken, 1956; 1959). Thus from Table 1 it can be seen that red meat with a calorific value of 120 resembles liver more closely than white meat, which is rated lowest in the order egg, liver, red meat and white meat.

**Table 1.** Proximate composition and calorific value of tuna meat

| Type of meat    | Moisture<br>g/100g | Fat<br>g/100g | Protein<br>g/100g | Carbohydrate<br>g/100g | Calorific<br>value<br>kcal/100g |
|-----------------|--------------------|---------------|-------------------|------------------------|---------------------------------|
| Tuna red meat   | 69.37              | 4.631         | 18.28             | 0.750                  | 120                             |
| Tuna white meat | 70.94              | 3.056         | 18.90             | 0.263                  | 104                             |
| Liver tissue    | 70.90              | 4.200         | 19.80             | 3.600                  | 133                             |
| * Egg whole     | 74.00              | 11.50         | 12.80             | 0.700                  | 159                             |

\* Values taken from Harrow & Mazoor (1962)



**Table 2.** *Amino acid composition and FAO/WHO suggested pattern of essential amino acids*

|                          | Amino acid composition g/100g (dry muscle) |            | Amino acid requirement g/day* |       |       |
|--------------------------|--------------------------------------------|------------|-------------------------------|-------|-------|
|                          | Red meat                                   | White meat | Infant                        | Child | Adult |
| Isoleucine               | 5.00                                       | 5.53       | 3.5                           | 3.7   | 1.8   |
| Leucine                  | 8.57                                       | 8.50       | 8.0                           | 5.6   | 2.5   |
| Lysine                   | 4.17                                       | 9.48       | 5.2                           | 7.5   | 2.2   |
| Methionine + cystine     | 3.88                                       | 3.80       | 2.9                           | 3.4   | 2.4   |
| Phenyl alanine           | 4.31                                       | 4.64       | 6.3                           | 3.4   | 2.5   |
| Tyrosine                 | **                                         | **         |                               |       |       |
| Threonine                | 4.99                                       | 5.38       | 4.4                           | 4.4   | 1.3   |
| Valine                   | 4.24                                       | 5.36       | 4.7                           | 4.1   | 1.8   |
| Histidine                | 2.38                                       | 5.36       | 1.4                           |       |       |
| Glutamic acid            | 13.35                                      | 14.01      |                               |       |       |
| Tryptophan               | 0.45                                       | 1.70       |                               |       |       |
| Arginine                 | 4.65                                       | 5.95       |                               |       |       |
| Serine                   | 3.83                                       | 4.59       |                               |       |       |
| Proline + hydroxyproline | 7.18                                       | 6.21       |                               |       |       |
| Aspartic acid            | 7.46                                       | 7.92       |                               |       |       |
| Glycine                  | 3.93                                       | 2.86       |                               |       |       |

\* FAO/WHO suggested pattern (1973)

\*\*Not determined

Listed in Table 2 are the amino acid compositions of red and white meat of tuna, along with the FAO/WHO (1973) suggested pattern of amino acid requirement for infant, child and adult per day. The data clearly shows that red and white meat are of comparable amino acid composition excepting lysine, histidine and tryptophan whose occurrences in white meat are more than twice that in red meat. But when the essential amino acid distribution is considered, the difference is confined only to lysine content.

However, from the FAO/WHO (1973) recommended pattern of amino acid requirement, it can be seen that 50 g of dry muscle of both red and white meat of tuna can easily meet the normal amino acid requirement of an adult human being, though in the case of infants and children it cannot provide the lysine required. Excepting for lysine, red meat is as rich a source of essential amino acids as white meat, especially in comparison with the amino acid composition of plant and cereal foods, in which lysine, threonine, isoleucine and methionine are reported to be limiting amino acids (Harden *et al.*, 1976).

Fig. 1 shows the graphic representation of electrophorogram of the aqueous extracts of white meat (W), red meat (R) and liver (L). The sarcoplasmic proteins of



**Fig. 1.** *Electrophorogram of the sarcoplasmic proteins of white muscle (W), red muscle (R) and liver tissue (L)*

all the three samples differ clearly from each other, particularly in low molecular weight components. In the sarcoplasm of liver there are about 7 protein bands in the low molecular weight region (bands 7 to 13), while the sarcoplasm of red and white meat respectively have 5 and 3 bands only. In the slow moving high molecular weight group (bands 1 to 6) also the number of protein bands is less in white meat (four) whereas liver and red meat sarcoplasm have 5 and 6 bands respectively. From these results, it is clear that red meat electrophorogram with 11 sarcoplasmic protein bands is more similar to liver with 12 sarcoplasmic

protein bands and superior to white meat with a sarcoplasmic protein pattern of 7 bands.

Table 3 summarises the ash, sodium, potassium, calcium and iron contents of tuna's red and white meat and tuna liver. It is seen that ash content of red meat is slightly less than that of white meat, but it is richer in sodium and iron, the latter occurring more than twice in quantity compared to white meat. On the other hand, white meat is characterised by the presence of potassium and calcium in higher amounts. The iron contents of liver and red meat show a clear similarity between the two, which perhaps is the reason for the similar pigmentation exhibited by them.

Vinogradov (1953), Parks & Rose (1933) also found red muscle to be generally rich in iron. Alexander (1955), Fujikawa & Naganuma (1936) reported similar observations in *Labeo rohita* and *Sardinella melanostrica* respectively. In the case of potassium, Thurston & McMaster (1960) reported a lesser concentration in red meat of halibut (*Hippoglossus hippoglossus*). Contrary to the present observations, Vinogradov (1953) found calcium content to be equal in red and white meat in general. However because of the major contribution of white muscle to muscular activity (Love, 1970) and the role of calcium in muscle contraction (Smellie, 1974) a higher concentration of calcium in white muscle seems more probable. The higher concentration of calcium in red meat over that of liver tissue can also be attributed to the association of the former in muscular activity with which the liver is not associated.

Further the high concentration of iron in red meat which is an indication of the presence of haemoglobin/myoglobin or other iron containing proteins/enzymes explains the higher amount of cellular oxidation going on in red muscle, a peculiar trait of liver tissue. The reported higher concentrations of cytochrome C, haemoglobin and myoglobin (Matsura & Hashimoto, 1954) and myoglobin and haemoglobin (Chinnamma, 1975) in the red meat of tuna endorses this view.

Striking differences are observed in the distribution of reducing sugar, lactic acid and inorganic phosphate in red and white meat of tuna. It is of interest to note that even though reducing sugar and glycogen are more in red meat, the end product of their catabolism namely lactic acid is present in larger quantities in white meat. Tsuchiya & Kunii (1960) have also made similar observations. Probably when once glycogen present in red muscle is degraded to simple sugar phosphates, a major part of them is transported to white muscle, where they are subjected to anaerobic glycolysis to give lactic acid. The occurrence of phosphorylase in larger quantities in red meat (Ogata & Mori, 1963) and higher amounts of L-glycerophosphate dehydrogenase and lactic dehydrogenase in white meat (Mellgren & Mathisen, 1966) lends support to this postulation.

The existence of comparatively larger quantities of inorganic phosphate (Table 4), an essential requirement for glycolysis in white

**Table 3.** Mineral composition of tuna meat

| Type of meat    | Ash<br>g/100g | Na<br>mg/100g | K<br>mg/100g | Ca<br>mg/100 | Fe<br>mg/100g |
|-----------------|---------------|---------------|--------------|--------------|---------------|
| Tuna red meat   | 1.224         | 53.74         | 238.4        | 134.4        | 11.05         |
| Tuna white meat | 1.704         | 47.50         | 391.2        | 178.8        | 4.75          |
| Liver tissue    | —             | —             | —            | 8.0          | 12.10         |
| * Egg whole     | —             | —             | —            | 54.0         | 2.70          |

\* Values taken from Harrow & Mazoor (1962)

—Values not determined



**Table 4.** *Composition of certain metabolites in tuna red and white muscles*

| Type of muscle | Reducing sugar<br>mg/100g | Lactic acid<br>mg/100g | Inorganic phosphate<br>mg/100g |
|----------------|---------------------------|------------------------|--------------------------------|
| Red            | 110.0                     | 23                     | 120                            |
| White          | 10.6                      | 44                     | 240                            |

meat and the extensive distribution of iron, the bio-oxygen receptor and hence an inhibitor of glycolysis, in red meat, further support the above view. The major role of white muscle in muscular activity especially in quick movement and the consequent instant energy requirements of white meat too, suggest the probability of a larger extent of glycolysis to occur in white meat in comparison with red meat.

From the foregoing results it is clear that red meat of tuna is in itself a specialised tissue resembling liver in many respects. Like liver, the red meat is a centre for biological oxidation and the aerobic metabolisms like citric acid cycle and  $\beta$  oxidation. It is also a store for the energy fuels like carbohydrate and fat. However the red meat is not as lethargic as liver in which respect it has similarities to heart tissue—a system adapted for continuous activity, deriving energy from aerobic metabolism.

This view is endorsed by Mellgren & Mathisen (1966), George (1962) and Biliniski (1963) against that of Breakken (1959). In this regard it may be said that white muscle contributes to quick movements and red meat to slow but continuous movement depending respectively on anaerobic and aerobic metabolisms for energy. The increased distribution of red muscle in continuously swimming fishes like tuna, mackerel and sardine and the absence or near absence of red meat in sluggish fishes substantiate this observation.

In the matter of food value too red meat occupies a higher status with higher amounts of carbohydrate, fat, essential minerals like iron, phosphorous, sodium and vitamins. The amino acid composition also proves that the red meat is highly nutritious though lysine, histidine and tryptophan

occur in smaller quantities than in white meat.

The authors are thankful to Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology, for encouragement and permission to publish the paper. They are indebted to Shri M. R. Nair for reading the manuscript and offering valuable suggestions for its improvement.

## References

- Alexander, K.M. (1955) *J. Anim. Morph. physiol.* **1**, 58
- Amano, K. & Bito, M. (1951) *Bull. Jap. Soc. Scient. Fish.* **16**, 10
- Anon (1966) *Comm. Fish. Rev.* **28**, 25
- Anon (1975) *FAO Year Book Vol. 40*, FAO of United Nations
- AOAC (1970) *Official Methods of Analysis* (Horwitz, W., Ed.) P. 426, Association of Official Agricultural Chemists, Washington
- Barker, S.B. & Summerson, W.H. (1941) *J. biol. chem.* **138**, 535
- Biliniski, E. (1963) *Can. J. Biochem. physiol.* **41**, 107
- Bligh, E. G. & Dye, W. J. (1959) *Can. J. Biochem. Physiol.* **37**, 911
- Breakken, O.R. (1956) *Nature.* **178**, 747
- \* Breakken, O.R. (1959) *Fisk. Dir. Skr. Serie. Teknologiske. Undersokelser.* **3**, 8
- Chinnamma George (1975) *Fish. Technol.* **12**, 70
- FAO/WHO (1973) *Energy and Protein Requirements—Ser.* **522**, FAO, Rome
- Fiske, C.H. & Subbarow, Y. (1925) *J. Biol. Chem.* **66**, 375
- Folin, O. & Malmros, H. (1929) *J. Biol. Chem.* **83**, 115
- Fujikawa, K. & Naganuma, H. (1936) *Bull. Jap. Soc. Scient. Fish.* **5**, 95

- George, J. C. (1962) *Am. Midle. Nat.* **68**, 487
- Harden, M.L. Stanaland, R., Briley, M. & Yang, S.P. (1976) *J. Fd Sci.* **41**, 1082
- Harrow, B. & Mazoor, A. (1962) In *Text Book of Biochemistry*. 8th edn., p. 628, W.B. Saunders Company, Philadelphia
- Hawk, B.P. (1954) In *Practical Physiological chemistry*. 13th edn., p. 545, McGraw-Hill Book Company Inc., New York
- Higashi, H. (1961) In *Fish as Food*. (George Borgstrom, Ed.) Vol. 1, p. 411, Academic press, London
- Igarashi, H., Zama, K. & Katada, M. (1957) *Bull. Jap. Soc. Scient. Fish.* **22**, 791
- Kavanagh, F. (1933) In *Analytical Microbiology*. p. 567, Academic Press, New York
- Lawrence, F. Ed. (1960) *Standard Methods for Examination of Water and Waste Water*. 13th edn., p. 374, American Public Health Association
- Love, R.M. (1970) In *Chemical Biology of Fishes*. p. 17, Academic Press, London
- Matsura, F., Baba, H. & Mori, T. (1953) *Bull. Jap. Soc. Scient. Fish.* **19**, 893
- Matsura, F. & Hashimoto, K. (1954) *Bull Jap. Soc. Scient. Fish.* **20**, 308
- \* Mellgren, S.I. & Mathisen, J.S. (1966) *Zellforsh. Mikrosh. Anal.* **71**, 169
- Nagayama, F. (1961) *Bull. Jap. Soc. Scient. Fish.* **27**, 1014
- Ogata, T. & Mori, M. (1963) *J. Histochem. Cytochem.* **11**, 645
- Ornstein, L. & Davis, B.J. (1964) In *Disc Electrophoresis*. Rreprinted by Distillation Products Industries, Rochester, New York
- Parks, T.B. & Rose, E.R. (1933) *J. Nutr.* **6**, 95
- Paul, C. P., Lis Buchter & Wierenga, A. (1966) *J. Agric. Fd Chem.* **14**, 1490
- Schwartz, A.L. & Rall, T.W. (1973) *Biochem. J.* **134**, 985
- Smellie, R.M.S. (1974) In *Calcium and Cell Regulation*. (Smellie, R.M.S. Ed.) p. 29., The Biochemical Society, London.
- Thurston, C.E. & McMaster, P.P. (1960) *Fd Res.* **25**, 229
- Tsuchiya, Y. & Kunii, K. (1960) *Bull. Jap. Soc. Scient. Fish.* **26**, 284
- Vinogradov, A.P. (1953) In *The Elementary Composition of Marine Organisms*. p. 647, Seers Foundation, New Haven
- Vogel, I.A. (1960) In *A Text Book of Quantitative Inorganic Analysis*. 3rd edn., p. 885, Longmans Green & Co. Ltd., London
- White, A., Handler, P. & Smith, E.L. (1973) In *Principles of Biochemistry*. 5th edn., p. 459, McGraw-Hill Kagakusha Ltd., Tokyo
- Watabe, S., Kanna, K. & Suzuki, T. (1977) *Bull. Jap. Soc. Scient. Fish.* **43**, 1353

---

\* Not referred to in original



## On Certain Allometric Relations of the Spiny Lobster *Panulirus polyphagus* (Herbst)

T. JOSEPH MATHAI\* AND A. K. KESAVAN NAIR

Central Institute of Fisheries Technology, Cochin-682 029

Certain allometric relations of the spiny lobster *Panulirus polyphagus* are derived. While the relation between tail length and tail weight is made for both the sexes together, separate relations are derived for the sexes in the case of tail length versus total length. For conservation and economic purposes, it appears that the under-sized ones are to be released alive.

Spiny lobsters popularly called as rock lobsters are commercially very important in view of its export potential. Of the six species of spiny lobsters recorded off Indian coasts, *Panulirus polyphagus* is the most predominant species off Goa. The same species is reported to be the most prevalent one off Bombay (Anon, 1962; Chhapgar & Deshmukh, 1961; Deshmukh, 1964). The relations derived here are restricted to *P. polyphagus* only. The lobster tails are graded according to their weight before they are packed for export. Difficulties have arisen to find the total length and weight of lobster caught in relation to the tail length and tail weight of the finished products. An attempt has been made by the authors to relate the tail length and tail weight and the total length and tail length of *P. polyphagus* and the results are reported in this communication.

### Materials and Methods

340 lobsters were collected from private trawlers at Panaji in 1972. The total length, total weight, carapace length, tail length and tail weight were measured.

### Results and Discussion

Tail lengths are plotted against tail weights (Fig. 1). Correlation co-efficient ( $r$ ) was found to be 0.94, suggesting a linear relationship. For the purpose of conversion, a regression line of tail length on tail weight was fitted as follows:

$$\text{Tail length} = 88.3400 + 0.4104 \times (\text{tail weight})$$

Standard error of the regression  
co-efficient = 0.0202

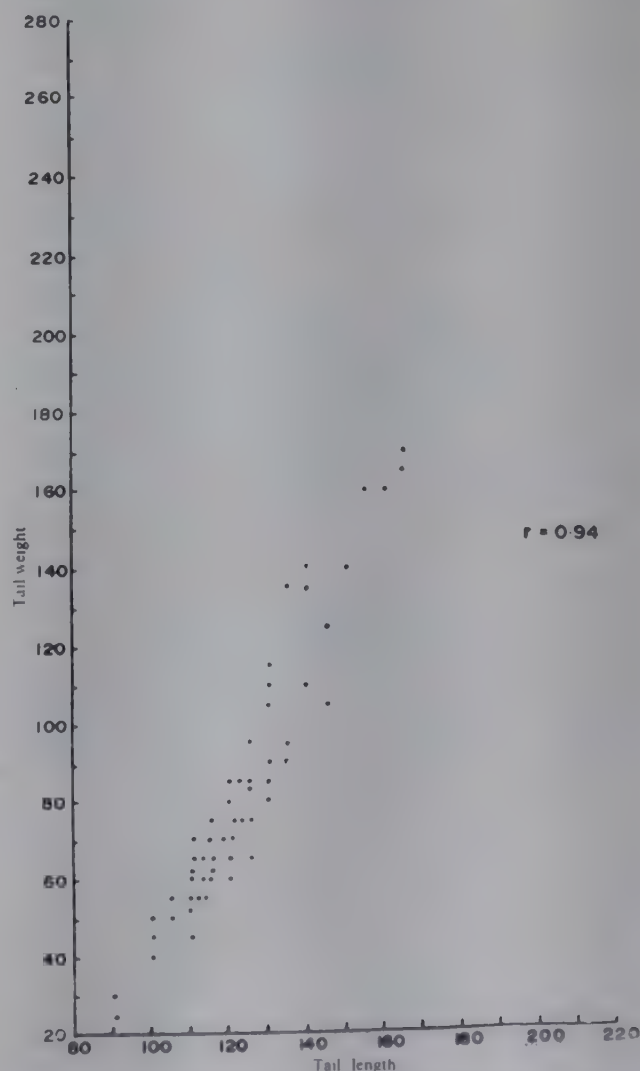


Fig. 1. Tail weight (g) x tail length (mm) of male and female

\*Present address: Goa Research Centre of Central Institute of Fisheries Technology, Panaji, Goa

Table 1. Analysis of covariance

|                           | df  | $\sum x^2$ | $\sum xy$  | $\sum y^2$ | Regression<br>co-efficient | Deviations from regression<br>df | ss        | ms      |
|---------------------------|-----|------------|------------|------------|----------------------------|----------------------------------|-----------|---------|
| Within males              | 99  | 29,202.19  | 52,813.63  | 102,770.91 | 1.8085                     | 98                               | 7,254.81  | 74.0287 |
| Within females            | 99  | 52,074.75  | 85,292.75  | 144,914.75 | 1.6379                     | 98                               | 5,214.55  | 53.2097 |
|                           |     |            |            |            |                            | 196                              | 12,469.36 | 63.6191 |
| Pooled, within            | 198 | 81,276.94  | 138,106.37 | 247,685.66 | 1.6992                     | 197                              | 13,014.31 | 66.0625 |
| Difference between slopes |     |            |            |            |                            | 1                                | 544.95    | 544.95  |

$\sum x^2$ ,  $\sum xy$  and  $\sum y^2$  are the corrected sums of squares and products. X and Y have usual meanings

Comparison of slopes:  $F = \frac{544.95}{63.62} = 8.57$  with 1 and 196 df (Significant at 1 % level)

Table 2. Analysis of variance of tail length

| Source        | ss          | df  | ms          |
|---------------|-------------|-----|-------------|
| Total         | 85,957.2188 | 199 |             |
| Between sexes | 4,680.2813  | 1   | 4,680.2813* |
| Error         | 81,276.9375 | 198 | 410.4895*   |

\* Significant at 0.1 % level

Table 3. Analysis of variance of total length

| Source        | ss         | df  | ms       |
|---------------|------------|-----|----------|
| Total         | 256,771.18 | 199 |          |
| Between sexes | 9,085.52   | 1   | 9085.52* |
| Error         | 247,685.66 | 198 | 1250.94* |

\* Significant at 1 % level

Table 4. Percentage composition of tail weights of lobsters sampled

| Tail grades | Weight g | Percentage composition |
|-------------|----------|------------------------|
| U/1         | 0- 28    | 0.826                  |
| 1/2         | 29- 56   | 16.528                 |
| 2/3         | 57- 84   | 55.371                 |
| 3/4         | 85-112   | 15.702                 |
| 4/5         | 113-140  | 4.958                  |
| 5/6         | 141-168  | 2.479                  |
| 6/7         | 169-196  | 0.826                  |
| 7/8         | 197-224  | 0.826                  |
| 8/9         | 225-252  | 0.826                  |
| 9/10        | 253-280  | 1.652                  |

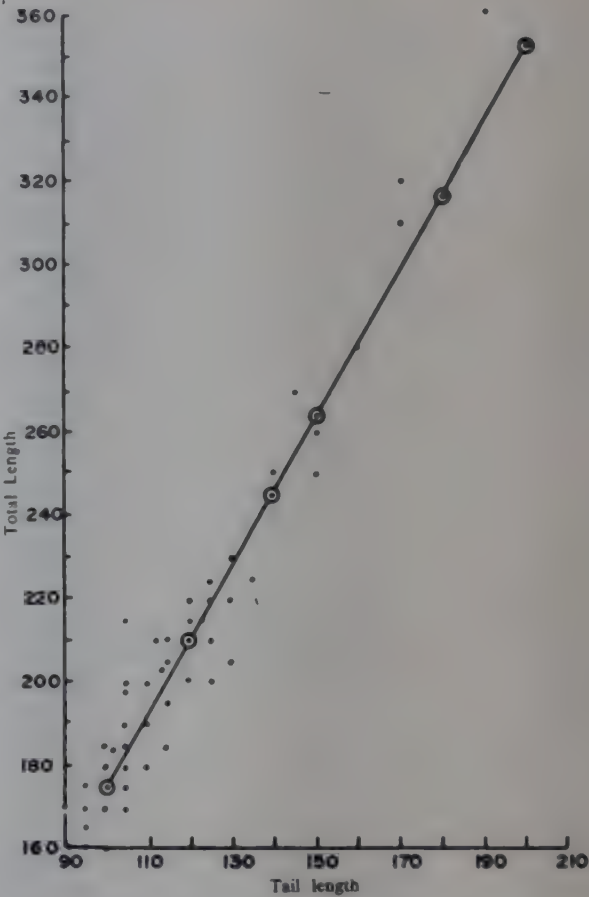


Fig. 2. Total length  $\times$  tail length (male)

As it was not possible to differentiate the sexes in the finished products at the processing factories, the form of relationship between tail length and tail weight could not be derived separately for male and female. Tail lengths were plotted against total lengths separately for males and females (Figs. 2 & 3). The correlation co-efficients between the two measurements were 0.96 for males and 0.98 for females. As these values were quite high,



analysis of covariance was made with the original measurements to ascertain whether the form of relationship between total length and tail length were the same for both the sexes. (Table 1). The F-value was found significant at 1% level. The slopes of the regression lines therefore are to be considered different indicating that the forms of relationship between total length and tail length, are different for males and females. A combined regression line for males and females would not hold good and individual relations were worked as follows:

Males: Total length =  $-5.6915 + 1.8085 \times (\text{tail length})$

Standard error of regression  
co-efficient = 0.0503

Females: Total length =  $11.6318 + 1.6379 \times (\text{tail length})$

Standard error of regression  
co-efficient = 0.0320

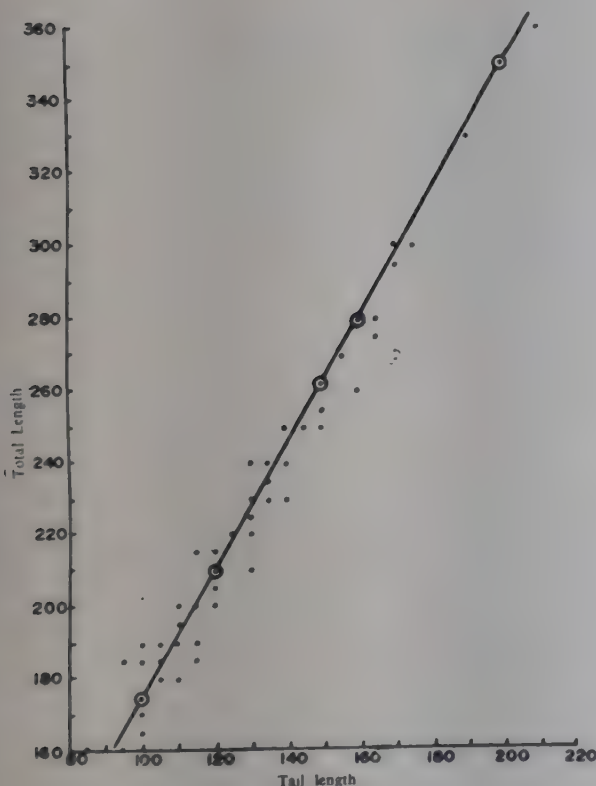


Fig. 3. Total length  $\times$  tail length (female)

The average total length and tail length for females were 203 mm and 115 mm respectively, while they were 216 mm and 125

mm respectively for the males. From the analysis of variance of tail length (X) and total length (Y), the average tail and total lengths were found significantly different for the sexes. (Tables 2 and 3). This may be due to the difference in growth rates and sizes in the sexes. The grades accepted by the factories and the percentage composition of tail weights of *P. polyphagus* sampled and graded are furnished in Table 4.

The predominant size group, namely, 29-112 g (corresponding to the grades 1/2 to 3/4) constituted 87.6% of the total lobsters sampled. The mode lies in the grade 2/3 and the corresponding weights are in the range of 57-84 g (55.371%). Their tail length taken from the regression lines are in the range of 112-123 mm. The corresponding total lengths of males and females are in the range of 196-216 mm and 195-213 mm respectively. But the tail weight of 29 g and over, that fall under the predominant size group is acceptable to the industry. The tail length corresponding to a tail weight of 29 g is calculated from the equation as 100 mm. The corresponding total lengths for males and females are calculated to be 175.5 mm and 175.7 mm respectively. Apart from purposes of conservation, for economic reasons also larger lobsters are preferred to younger ones, to get better grades of tail. Widening the mouth of the trap will also allow the entry of young ones and consequently in traps, all sizes will be caught. The young ones that are thus trapped are to be released to the water alive.

The authors are grateful to Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology for providing all the facilities to carry out this work. They are also grateful to Dr P. N. Kaul and Shri R. Balasubramanyan for the criticism of the paper.

## References

- Anon (1962) *Indian Fish. Bull.* **9**, 18
- Chhapgar, B.F. & Deshmukh, S.K. (1961) *J. Bombay nat. Hist. Soc.* **58**, 632
- Deshmukh, S. K. (1964) *J. Bombay nat. Hist. Soc.* **61**, 150





## Rational Exploitation of *Catla catla* (Ham) from Hirakud Reservoir - A Preliminary Account

V. C. GEORGE, A. A. KHAN AND M. D. VARGHESE

*Burla Research Centre of Central Institute of Fisheries Technology, Burla-768 017*

Frame nets and simple gill nets of identical mesh size were experimented to determine their comparative efficiency for exploiting economic size group of *Catla catla*. The results indicated that frame nets of 90 mm mesh bar as the most effective.

Gangetic carps occupy the most important place in reservoir fisheries. According to Natarajan (1976) *C. catla* is a highly priced economic carp. Jhingran (1977) and Natarajan (1976) emphasized the importance of stocking this species in reservoirs in view of its rapid growth. The occurrence of *C. catla* has been recorded in almost all reservoirs. In Rihand, *C. catla* is the only major carp that dominates the fishery (Natarajan, 1976). Job *et al.* (1955) recorded the occurrence of *C. catla* in Mahanadi river. Subsequently Sulochanan *et al.* (1968), George *et al.* (1973) and Khan *et al.* (1974) confirmed that this species contributed to one of the most viable and productive fisheries of Hirakud reservoir. These workers have suggested frame nets as the most suitable gear for catching commercially important fishes of the reservoir.

But their conclusions are based on observations with nets of 75 mm bar.

Znamensky (1967) recommended frame nets of 75,85 and 100 mm mesh bar for Hirakud reservoir. However, hitherto no attempt has been made to find out the optimum mesh size for the exploitation of commercial size groups of *C. catla*. Studies on these lines are of vital significance as these investigations apart from evolving an effective gear for the capture of *C. catla* will also pave way for the proper management and conservations of the fishery. To achieve this objective different designs of nets were experimented during November 1977 to December 1978 and the results presented in this communication.

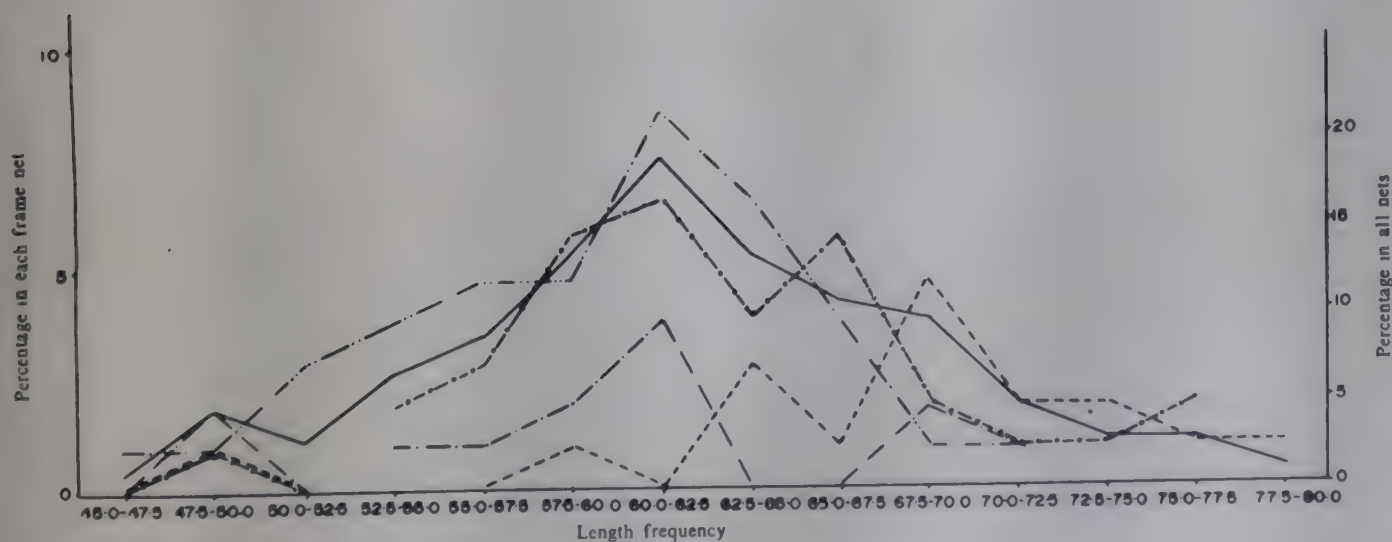


Fig. 1. Percentage representation of *C. Catla* in frame nets and its length frequency distribution





Table 2. Percentage weight of *C. catla* and yield per unit area (1000 sq.m) in frame and simple gill nets

| Mesh bar<br>mm | Area<br>sq.m | Frame net             |            |                              | Simple gill net    |            |                              |
|----------------|--------------|-----------------------|------------|------------------------------|--------------------|------------|------------------------------|
|                |              | Total<br>weight<br>kg | Percentage | Yield per<br>unit area<br>kg | Total weight<br>kg | Percentage | Yield per<br>unit area<br>kg |
| 75             | 41343        | 42.40                 | 8.05       | 1.025                        | 8.60               | 1.63       | 0.208                        |
| 90             |              | 190.80                | 36.24      | 4.614                        | 5.90               | 1.13       | 0.142                        |
| 105            |              | 168.98                | 32.09      | 4.087                        | 16.20              | 3.08       | 0.391                        |
| 120            |              | 79.00                 | 15.00      | 1.910                        | 14.65              | 2.78       | 0.354                        |

Table 3. Analysis of variance of *C. catla*

| Source | ss      | df  | ms     | f      |
|--------|---------|-----|--------|--------|
| Total  | 47.9352 | 599 |        |        |
| Nets   | 4.3946  | 1   | 4.3946 | 67.82* |
| Meshes | 0.9545  | 3   | 0.3182 | 4.91*  |
| Days   | 8.8124  | 74  | 0.1191 | 1.84*  |
| Error  | 33.7737 | 521 | 0.0648 |        |

\* Indicates significance at 1 % level

Materials and Methods

Two shots of frame and simple gill nets of mesh sizes 75, 90, 105 and 120 mm bar were operated at different locations in the reservoir. The design details of nets are given in Table 1. The nets were suitably set so as to get equal chances for all nets. The nets were surface set in the evening and hauled up the next morning. The morphometric data of each fish caught by the different nets were recorded.

Results and Discussion

The catch per unit area (kg/1000 sq.m) for individual net is given in Table 2. Fig. 1 depicts the percentage length frequency distribution of *C. catla* in all frame nets and in individual frame nets. Fig. 2 shows the percentage representation of predominant size groups in each frame net. Figs. 1, 2 and Table 2 clearly indicate that net with 90 mm mesh bar as the most effective for capturing the predominant size groups of *C. catla*, followed by net with 105 mm mesh bar.

Analysis of variance (Table 3) shows that between nets, between meshes and

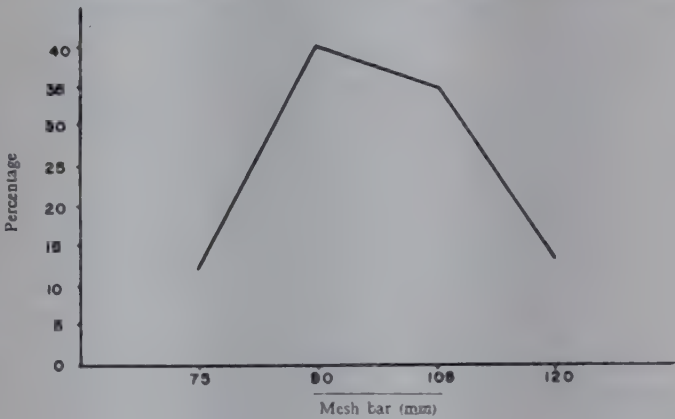


Fig. 2. Percentage representation of predominant size group of *C. Catla* in each frame net

between days, variations are highly significant ( $p < 0.01$ ). The average catch of the simple gill nets and frame nets was 0.0302 and 0.2014 kg respectively in the logarithmic scale. The average catch of nets with different meshes, namely, 75, 90, 105 and 120 mm mesh bar were 0.0636, 0.1584, 0.1498 and 0.909 kg respectively in logarithmic scale, indicating better performance of 90 and 105 mm mesh bar. Simple gill nets of 105 mm bar landed more *C. catla* while frame nets of 90mm bar scored the maximum.

As seen from Tables 2 and 3, frame nets caught more *C. catla* than simple gill

nets. The frame nets landed 91.38% of the total catch by weight (Table 2). This was further confirmed by the analysis of variance (Table 3). Though 105 mm mesh bar simple gill nets caught more *C. catla*, the quantum of catch was negligible when compared to that of frame nets. The observation that frame nets are more efficient than other types of gill net is also noticed by earlier workers (Sulochanan *et al.* 1968).

Among frame nets the maximum catch was obtained with 90 mm mesh bar nets. The catch by this net was 1.129 to 4.5 times more than that of other frame nets. A similar trend is noticed with regard to the number of fishes caught. Analysis of variance of catch also confirmed that 90 mm bar frame net is superior to others.

The predominant size group of *C. catla* (Fig. 1) ranging from 55 to 70 cm constituted 73.58% of the total catch. This size group is worth commercial exploitation as it represented the economical size group of *C. catla* in Hirakud reservoir. Jhingran & Ghosh (1978) fixed 55 cm length as the minimum size limit of *C. catla* for exploitation from river Ganga. According to Natarajan & Jhingran (1963) those between 50 and 55 cm length range attain maturity. In the absence of published records with respect to the biology of *C. catla* from Hirakud reservoir, it is presumed that fishes which have crossed this size are matured ones and hence can be exploited. Since 90 mm mesh bar net landed 40%

of the predominant size group, it is better suited for the exploitation of *C. catla*.

The authors are grateful to Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology, Cochin for valuable suggestions, Shri S. Gopalan Nayar, Scientist for helpful criticism of the manuscript, Shri H. Krishna Iyer, Scientist, for the statistical analysis of the data and Shri G. Narayanappa, Scientist for the services rendered during the initial stages of the work.

## References

- George, V.C., Naidu, R.M. & Kunjipalu, K.K. (1973) *Fish. Technol.* **10**, 73
- Jhingran, V.G. (1977) *Fish and Fisheries of India*, 1st edn., P. 954, Hindustan Publishing Corporation (India), 6-UB, Jawahar Nagar, Delhi-110 007
- Jhingran, A.G. & Ghosh, K.K. (1978) *Aquaculture*, **4**, 141
- Job, T.J., David, A. & Das, K.N. (1955) *Indian J. Fish.* **2**, 1
- Khan, A.A., Naidu, R.M. & Narayanappa, G. (1974) *Fish. Technol.* **11**, 73
- Natarajan, A.V. (1976) *Indo-Pacif. Fish. Coun. Symp.* 26 June
- Natarajan, A.V. & Jhingran, A.G. (1963) *Proc. Nat. Inst. Sci. India*, **29** (B), 326
- Sulochanan, P., George, V.C. & Naidu, R.M. (1968) *Fish. Technol.* **5**, 81
- Znamensky, Yu. (1967) *FAO/UNDP. Rep.* (TA), TA 2290



# Effect of Electric Stimulation on Heart Beat and Body Muscle in Fish

K. P. BISWAS

*Orissa Maritime and Chilka Area Development Corporation, Bhubaneswar*

AND

S. P. KARMARKAR

*Wilson College, Bombay*

The effect of AC and DC electric stimulations on the heart-rate and the entire body of *Heteropneustis fossilis*, *Tilapia mossambica* and *Macrobrachium rosenbergii* were studied and presented in kymograph tracings. The reaction of spinal cord in *Puntius ticto*, *Heteropneustis fossilis* and *Tilapia mossambica* to D.C. field was observed to find out its role in electric shocks. A test-check of the electrical resistance of a few species was also conducted. The effect of D.C. and A.C. on the body muscle was found to be the same as that in the case of frog. Different degrees of cardiac slowing were observed in AC and DC. Unbalanced galvanotropic movements were also noticed in spinal fishes.

Electric shock response in man (Dalziel & Lee, 1968) has shown that electric current is the best measure of the strength of the sensible shock effect. Similar results were observed in fishes also (Cujnat, 1967). The primary function of the electro fishing system is to establish an electric current in water near the fish. Depending on the ratio of fish and water conductivity a portion of this current will pass through the fish and elicit the desired response. The skin of fish with the numerous sensory organs is an important receptor for physical and chemical stimuli (Brett, 1957). In this paper the authors report their attempts to measure the electrical resistance of the skin and body of fish, the contraction of fish body by direct currents and also the effect of electrical stimulation on the heart beat in fishes.

## Materials and Methods

The electrical resistance of the skin and body and also between different points of the body were measured by using a dermometer described by Whelan (1950) which had a range of 1,000 to 4,50,00,000 ohms and about 5% accuracy. Live fishes were measured for length and maximum width and kept in between the folds of filter paper to remove water from the surface. One

end of the silver electrode was connected to the instrument and the other end pressed against the fish, the instrument switched on and adjusted to  $2\mu\text{A}$ . The resistance of the fish was directly read from the voltmeter and multiplied by 10 or 100 depending the range selected. The resistance between different body parts, namely, mouth to top of head, mouth to mid-dorsal fin, mouth to caudal peduncle and mouth to vent were measured with platinum electrodes. To record the contraction of the body in *Heteropneustics fossilis*, its peduncle was clamped firmly, upper jaw connected through a thread to a lever provided with a writing pen. The writing pen touched the black surface of a smoked paper wound round a cylindrical drum moving at constant speed. The pen drew a horizontal line (abscissa) on the smoked paper when the drum rotated. The brain together with a portion of spinal cord was destroyed by inserting and rotating a needle. The lever turned on the fulcrum, jerked up and the pen drew a curve on the smoked paper. The time was furnished by a tuning fork vibrating at 100 times per second.

The effect of electrical shock on the heart rate by the applied underwater field was recorded graphically on a constant



slow moving drum. The fish after destroying the brain and spinal cord was firmly clamped upside down at the bottom of the experimental tank, where a homogenous electrical field was created by two copper plates, placed vertically along the tank extremities. The heart of the animal was then exposed and the ventricle was connected to a lever, fitted with a writing point, which in turn touched the blackened surface of a tracing paper wound round a drum. After recording normal heart beat for some time, the animal as a whole was subjected to electric shocks of different intensities and the heart rhythm was recorded for some time. The recordings continued even after switching off the current till the heart came to normal rhythm. Currents of different forms and stimulations of different types were tested on *H. fossilis* and *Tilapia mossambica*. Visual observations of the effect of electrical shock on the heart rate of *Macrobrachium rosenbergii* were also made. The spinal cord of *Puntius ticto*, *H. fossilis* and *T. mossambica* were severed first behind the supraoccipital and were allowed to rest for two hours before exposing them to electric shocks. The experimental set up and the procedure were similar to that already described. Observations were made for the sensitivity and response in these animals and the minimum field strength required to elicit response in them.

## Results and Discussion

The resistance of *Mystus aor* was the lowest ( $6 \times 10^3 - 7 \times 10^3$  ohms) and of *M. rosenbergii* the highest ( $24 \times 10^3 - 25 \times 10^3$  ohms) as shown in Table 1. The result of tolerance test showed 100 per cent mortality in *M. aor* and *Cirrhina mrigala* within 25 to 35 and 65 to 75 min after exposure to current. 60% of *Notopterus notopterus* and 40% of *M. rosenbergii* died after 85 to 105 and 92 to 120 min respectively. 25 per cent of *Labeo rohita* and *Catla catla* were found dead within 115 to 135 and 218 to 255 min respectively after exposure to current (Table 2). An increase in the latent period by 20 milliseconds under 3 volts was recorded over that of 8 and 17 volts in *H. fossilis*. A sharp rise (contraction) with two peaks and a gradual fall (relaxation) were observed at all the shock intensities tested. The contraction phase lasted for

80, 160 and 180 milliseconds for 3, 8 and 17 volts respectively. The corresponding relaxation phases were 120, 140 and 110 milliseconds. In *T. mossambica* two distinct curves with double peaks and a latent period of 90 milliseconds were recorded for D.C. 3, 8 and 17 volts. At 3 volts the amplitude of the second curve was more than the first one. But the amplitude of the first curve increased with the intensity of current (8 and 17 volts). The contraction phase lasted for a higher period in 7 volts than the relaxation period.

At 20 volts the curve of muscle twitch in *H. fossilis* showed a sharp rise and fall with two small peaks at the top. When raised to 40 volts, two peaks along with a wide valley at the top was noticed. At 60 volts, a single peak of highest amplitude was drawn. The contraction phases remained for 190, 450 and 425 milliseconds for 20, 40 and 60 volts respectively. The corresponding relaxation phases however lasted for 20, 30 and 185 milliseconds respectively. The contraction of body muscle of *T. mossambica* due to A.C. 20, 40, 60 and 80 volts revealed the formation of two curves during each stimulus. The height of the second curve was more than the first and a double peak was noticed in the second curve at 80 volts.

The latent period was prolonged by 15 to 50 milliseconds from the third stimulation onward. The length of contractions were also increased irrespective of D.C. and A.C. After an initial rise during the first few contractions, the height of the curve reduced uniformly. The relaxation phase was prolonged with the number of stimuli and after 30 to 40 contractions, the writing lever took several milliseconds to return to the baseline.

The heart rate of *M. rosenbergii* when exposed to field intensity of 0.0792 to 0.2376  $\delta$  for 15-180 seconds, showed a decrease of 10-12 per min during the shock. But heart beat decreased under current intensities of 0.792 to 1.98  $\delta$  till the heart stopped during narcosis. Increasing shock intensity suppressed heart beat (61-116 per min) but accelerated to 146-212 per min immediately after recovery from narcotic condition



Table 1. Electrical resistance of the body of different species of fish\*

| Species                              | Length<br>mm | Animals<br>tested | Electrical resistance in<br>ohms               |                                              |                                              |                                              | Electrical resistance<br>of body |                        |
|--------------------------------------|--------------|-------------------|------------------------------------------------|----------------------------------------------|----------------------------------------------|----------------------------------------------|----------------------------------|------------------------|
|                                      |              |                   | Mouth to<br>top of<br>head                     | Mouth to<br>middorsal<br>fin                 | Mouth to<br>caudal<br>peduncle               | Mouth to<br>vent                             | ohms/cm                          |                        |
| <i>Macrobrachium<br/>resenbergii</i> | 95-115       | 14                | —                                              | —                                            | 27 x 10 <sup>3</sup><br>29 x 10 <sup>3</sup> | —                                            | 24 x 10 <sup>3</sup>             | -25 x 10 <sup>3</sup>  |
| <i>Labeo rohita</i>                  | 180-205      | 16                | 11 x 10 <sup>3</sup><br>12 x 10 <sup>3</sup>   | 13 x 10 <sup>3</sup><br>18 x 10 <sup>3</sup> | 15 x 10 <sup>3</sup><br>21 x 10 <sup>3</sup> | 12 x 10 <sup>3</sup><br>16 x 10 <sup>3</sup> | 7 x 10 <sup>3</sup>              | -9.5 x 10 <sup>3</sup> |
| <i>Catla catla</i>                   | 160-195      | 12                | 10 x 10 <sup>3</sup><br>13 x 10 <sup>3</sup>   | 15 x 10 <sup>3</sup><br>16 x 10 <sup>3</sup> | 15 x 10 <sup>3</sup><br>18 x 10 <sup>3</sup> | 13 x 10 <sup>3</sup><br>15 x 10 <sup>3</sup> | 10 x 10 <sup>3</sup>             | -11 x 10 <sup>3</sup>  |
| <i>Cirrhina mrigala</i>              | 90-100       | 16                | 12 x 10 <sup>3</sup><br>12.5 x 10 <sup>3</sup> | 16 x 10 <sup>3</sup><br>21 x 10 <sup>3</sup> | 22 x 10 <sup>3</sup><br>25 x 10 <sup>3</sup> | 15 x 10 <sup>3</sup><br>16 x 10 <sup>3</sup> | 75 x 10 <sup>3</sup>             | -8 x 10 <sup>3</sup>   |
| <i>Notopterus notopterus</i>         | 100-120      | 12                | 10 x 10 <sup>3</sup><br>13 x 10 <sup>3</sup>   | 15 x 10 <sup>3</sup><br>16 x 10 <sup>3</sup> | 22 x 10 <sup>3</sup><br>25 x 10 <sup>3</sup> | 15 x 10 <sup>3</sup><br>16 x 10 <sup>3</sup> | 8 x 10 <sup>3</sup>              | -9 x 10 <sup>3</sup>   |
| <i>Mystus aor</i>                    | 153-184      | 10                | 12 x 10 <sup>3</sup><br>21 x 10 <sup>3</sup>   | 15 x 10 <sup>3</sup><br>20 x 10 <sup>3</sup> | 26 x 10 <sup>3</sup><br>30 x 10 <sup>3</sup> | 15 x 10 <sup>3</sup><br>20 x 10 <sup>3</sup> | 6 x 10 <sup>3</sup>              | -7 x 10 <sup>3</sup>   |

\*Air temperature 33°C, water temperature 32.5°C

Table 2. Effect of D.C. shocks (direct contact) on animals\*

| Species                              | Size range<br>mm | Animals<br>tested | Contact<br>voltage in<br>volts | Effect of<br>direct shock<br>Immediate<br>effect | Percentage<br>death | Time required<br>for death<br>after shock<br>treatment min |
|--------------------------------------|------------------|-------------------|--------------------------------|--------------------------------------------------|---------------------|------------------------------------------------------------|
| <i>Labeo rohita</i>                  | 180-205          | 12                | 1.4-2.0                        | No narcosis                                      | 25                  | 115-135                                                    |
| <i>Catla catla</i>                   | 160-195          | 12                | 1.4-1.8                        | No narcosis                                      | 25                  | 218-255                                                    |
| <i>Cirrhina mirigala</i>             | 90-100           | 12                | 2.1-2.4                        | Narcosis for<br>12-22 sec                        | 100                 | 65-75                                                      |
| <i>Mystur aor</i>                    | 153-184          | 10                | 2.1-2.3                        | Narcosis for<br>56-84 sec                        | 100                 | 25-35                                                      |
| <i>Notopterus<br/>notopterus</i>     | 100-120          | 10                | 1.4-2.1                        | Narcosis for<br>5-7 sec                          | 60                  | 85-105                                                     |
| <i>Macrobrachium<br/>rosenbergii</i> | 95-115           | 10                | 2.6-2.8                        | No narcosis                                      | 40                  | 92-120                                                     |

\* Intensity of shock 25  $\mu$ A, duration 10 sec, temperature of water 32.5°C

Table 3. Effect of D.C. shocks on heart rate of *Macrobrachium rosenbergii*\*

| Current density<br>in which the<br>animal was<br>narcosed | Animals<br>tested | Heart rate per minute     |                          |                                       | Electric<br>shock<br>sec |
|-----------------------------------------------------------|-------------------|---------------------------|--------------------------|---------------------------------------|--------------------------|
|                                                           |                   | Before<br>shock<br>Normal | During<br>shock<br>taxis | After<br>recovery<br>from<br>narcosis |                          |
| 0.0792                                                    | 12                | 124-128                   | 114-116                  | —                                     | 150-180                  |
| 0.2376                                                    | 10                | 126-130                   | 96-104                   | —                                     | 25-24                    |
| 0.7920                                                    | 12                | 104-109                   | 83-87                    | 146-150                               | 27-31                    |
| 0.9900                                                    | 12                | 172-176                   | 75-80                    | 194-198                               | 23-28                    |
| 1.9800                                                    | 12                | 176-180                   | 61-64                    | 200-212                               | 30-34                    |

\* Electrical resistance 22.5 x 10<sup>3</sup> ohms/cm<sup>2</sup>, length of fish 120-170 mm, weight 25-55g, water temperature 29°C



(Table 3). *T. mossambica* showed slowing of heart beat soon after exposition at D.C. 0.8 $\delta$  and 1.2 $\delta$  caused momentary cardiac slowing, but afterwards came back to normal rhythm prior to shock treatment. *H. fossilis* when subjected to increasing intensity of A.C., its heart curve showed initial rise during first few contractions followed by uniform decrease till the current intensity reached 0.55 $\delta$ . At a field intensity of 0.75 $\delta$  irregular fluttering of heart was recorded which regained normal rhythm when the current was switched off. Gradual cardiac slowing was observed when *H. fossilis* exposed to sharp current rise of 0.35 and 0.55 $\delta$  and heart stopped in the relaxing phase after 35 and 11 contractions respectively. Exposure at higher current intensity (0.75 $\delta$ ) caused stoppage of heart beat after 3 contractions.

Stimulating the heart with current intensities at 0.7 $\delta$  and 1.1 $\delta$  in a media of calcium chloride (1:1500) having a resistance of  $8 \times 10^3$  ohms/cm<sup>2</sup>, the relaxation after each contraction became more and more incomplete, until finally the heart stopped

in a tonically contracted condition. In potassium chloride solution of identical concentration and resistance, the tonic condition of the heart increased with 0.2 to 0.75 $\delta$  current and the contractions lasted as long as the current flow continued. During treatment with current intensities of 0.2 $\delta$  and 0.35 $\delta$ , however, the amplitude of heart beats was more when compared to shocks of higher intensities.

When *P. ticto* was stimulated with the increasing field intensity, they responded for first reaction (sensing of surrounding electric field) vibration and leap frogging movement towards the anode and strong swimming movement towards the positive electrode at times accompanied by anodic curvature with head turning towards the anode at currents of 0.4 to 0.048 $\delta$  0.08 to 0.096 $\delta$  and 0.112 to 0.16 $\delta$ , respectively. 80 to 90% fishes reached for anodic movement in the second and third stage of reaction, while 10 to 20% exhibited vibration of fins accompanied by anodic curvature turning their heads towards the positive electrode in varying current intensities (Table 4).

Table 4. Response of *Puntius ticto* to D.C. shocks\*

| Classification of reaction | Response with the increasing intensity                                                   | Current density in $\mu$ A required to bring out the response | Percentage responded |
|----------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------|----------------------|
| Stage-I                    | Expansion of dorsal, pectoral, pelvic fins accompanied by tremour of caudal fins         | 0.04-0.048                                                    | 100                  |
| Stage-II                   | Leaped towards the +ve electrode a little with jerk of body                              | 0.08-0.96                                                     | 90                   |
|                            | Vibration of pectoral fins and turn its head to the +ve electrode                        | 0.08-0.96                                                     | 10                   |
| Stage-III                  | Moved towards the +ve electrode with jerks of body                                       | 0.112-0.16                                                    | 80                   |
|                            | Bending of body turning its head towards +ve electrode                                   | 0.112-0.016                                                   | 10                   |
|                            | Anodic curvature of the body and turned to anode with movement towards the +ve electrode | 0.112-0.16                                                    | 10                   |

\* Electrical resistance of water  $16 \times 10^3$  ohms/cm<sup>2</sup>, size of fish 72-90 mm, temperature 24°C, number of animals tested 20

Table 5. Response of *Heteropneustis fossilis* to D.C. shocks\*

| Classification of reactions | Response with the increasing intensity                                                                                                                                     | Current density in $\mu\text{A}$ required to bring out the response | Percentage responded |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------|
| Stage-I                     | Vibration of barbels and occasional bending of the body                                                                                                                    | 0.016–0.04                                                          | 100                  |
| Stage-II                    | Forced swimming towards the anode with bending of body and sideward movement of head till they reached the electrode                                                       | 0.096–0.12                                                          | 81.4                 |
|                             | Bending of body turning its head towards the anode till their body became parallel to current lines, when they moved violently towards the +ve electrode in that condition | 0.12–0.16                                                           | 8.6                  |
| Stage-III                   | Immobilized with expanded fins and maxilla facing +ve electrode                                                                                                            | 0.16–0.176                                                          | 64.4                 |
|                             | Curvature of body pointing their head and tail towards the anode                                                                                                           | 0.16–0.176                                                          | 35.6                 |

\* Resistance of water  $19 \times 10^3$  ohms/cm<sup>2</sup>, size of fish 100-124 mm, temp. 25°C, fishes tested 18

Subjecting *H. fossilis* to increasing field intensity, their reactions were observed at three stages in the current densities of 0.016 to 0.04 $\delta$ , 0.096 to 0.16 $\delta$  and 0.16 to 0.176 $\delta$  respectively. Forced swimming towards the positive electrode and immobilization near the anode were observed in 81.4 and 64.4% cases, whereas, initial bending of the body during second stage and the anodic curvature during third stage were noticed in 8.6 and 35.6% of fishes. All the organisms responded for vibration of barbels and bending of body during the first reaction (Table 5).

All the *T. mossambica* showed quivering of pectoral, pelvic and caudal fins followed by the curvature of body in current intensities of 0.08 to 0.096 $\delta$ . With the rise of field densities of 0.144 to 0.16, 75% of them remained either perpendicular or at 45° to the field lines without any movement. The remaining 25% glided towards the cathode

in an unbalanced manner. Change of body colour and discharge of milt after cease of current flow were noticed in 12.5% animals at this stage. Momentary muscular rigidity in up side down condition occurred in case of 12.5% fishes at current intensities of 0.16 to 0.24 $\delta$  (Table 6).

In order to control fish by electricity in freshwater, a high field strength is required because the conductivity of the fish is higher than that of the water (Bary, 1956). When a fish comes to an electric field, the charge induced on the fish is proportional to the cube of its body length (Kuroki, 1952). According to Holzer (1931), when the conductivity of animal body is higher than the surrounding water (fresh water) all the potential lines are directed towards the body with better conductivity and the fish is thus satisfactorily influenced by electricity. The knowledge of electrical resistance of the animal body is thus important in initiating



**Table 6.** *Response of Tilapia mossambica to D.C. shocks\**

| Classification of reactions | Response with the increasing intensity                                                                  | Current density in $\mu\text{A}$ required to bring out the response | Percentage responded |
|-----------------------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------|
| Stage-I                     | Curvature of the body, quivering of tail, pectoral and pelvic fins                                      | 0.08–0.096                                                          | 100.0                |
| Stage-II                    | Un-co-ordinated movement towards the negative electrode                                                 | 0.144–0.16                                                          | 25.0                 |
|                             | Remain either perpendicular or at $45^\circ$ to the field lines                                         | 0.144–0.16                                                          | 75.0                 |
|                             | Body colour darkens deep black during current flow and discharge of milt after stoppage of current flow | 0.144–0.16                                                          | 12.5                 |
| Stage-III                   | Momentary muscular rigidity and stayed at the bottom with ventral surface up                            | 0.16–0.24                                                           | 12.5                 |

\* Resistance of water  $15 \times 10^3$  ohms/cm<sup>2</sup>, size of fish 90–122 mm, temperature  $23.5^\circ\text{C}$ , number of fishes tested 24

the responses and determination of reaction thresholds.

Halsband (1968) measured the electrical resistance of trout body through water media. In the present study the electrical resistance was determined directly by the dermatometer and represented as ohms/cm<sup>2</sup> of body and between different points of body as studied by Denzer (1956) for rainbow trout. The electrical resistance (ohms/cm<sup>2</sup>) was found to be lowest in case of *M. aor* (devoid of scale) and highest in *M. rosenbergii* (with a chitinous shell). As observed by Denzer (1956) the resistance between mouth to caudal peduncle of all the test animals was highest than between any other part of the body which is due to the largest body extremities of the animal. It is observed that the order in which fishes affected by electric shocks are *M. aor*, *C. mrigala*, *N. notopterus*, *L. rohita* and *C. catla*. A fixed amount of current ( $25\mu\text{A}$ ) was allowed to pass through their body by direct contact for a period of 10 seconds. The contact voltage varied from 1.4 to 2.4 volts depending on the species. The severity of shocks (as observed by the percentage of death and the

time required for death) indicate that the test fishes are sensitive to D.C. as described earlier.

The skeletal muscle, or its nerve when stimulated by a single induction current resulted in a single short sharp contraction followed immediately by a relaxation (Starling, 1947). To determine the time relations of muscle contraction it was necessary to employ the graphic method. The mechanical changes that the fish as a whole had undergone by D.C. and A.C. were represented by kymograph tracings along with a time record.

Starling (1947) demonstrated that the simple muscle twitch in frog consists of three main phases, namely, the latent period (during which no apparent change takes place in the muscle), contraction (a phase of shortening) and a phase of relaxation. When the whole body of *H. fossilis* and *T. mossambica* were stimulated by D.C. of varying intensities, the latent period was delayed in currents of low intensities. According to Meyer—Waarden (1957) the

effective period inducing narcosis (relaxation of muscle) in fishes is inversely proportional to the intensity of the field. The occurrence of second contraction before attaining complete relaxation in both the test fishes can be explained by Pfluger's principle (Pfluger, 1853), that is, the closing of the circuit has a stimulating effect on the nerves or muscles within the range of the cathode and the opening of the circuit has also a stimulating effect within the range of the anode and the reaction to the opening of the circuit is much smaller than the reaction to the closing of the circuit. But in case of D.C. on *T. mossambica*, the amplitude of the second curve (due to opening of the circuit) was found to be greater than 3 volts when compared to currents of 8 and 17 volts.

In A.C. also, double curves for each stimulation was obtained in case of *T. mossambica*. But in *H. fossilis*, two peaks at 20 and 40 volts and a single peak of highest amplitude during 60 volts could be explained by summation effect of two stimuli during closing and opening of the circuit. When the intervals between two currents were shortest, a greater response was observed with a single peak. But during longer intervals between the first and second shocks, as in case of 20 and 40 volts, the excitatory condition of muscle was maintained, so that instead of forming two isolated muscle twitch a second contraction occurred before the fading of the effect of previous stimulus forming two peaks in one curve. The effect of repeated stimulation by both D.C. and A.C. on *H. fossilis* showed that the latent period was prolonged, with the length of contractions. The A.C. and interrupted D.C. caused heavy stimulation of the central nervous system which led to tetanic condition of the muscles (Meyer-Waarden, 1957). According to him, this state of immobility is the consequence of cramp occurring in the muscles caused by the superposition of numerous individual contraction as observed in the present test with *H. fossilis* for A.C. William (1885) demonstrated in the eel that almost any sort of peripheral stimulation caused inhibition of the heart beat and this appeared to be generally true in unanesthetized fish. Cardiac slowing in *M. rosenbergii* was observed during the application of D.C. depending on the current intensity. A

slight hyperactivity of the heart was noticed after recovery from narcosis. Momentary cardiac inhibition of *T. mossambica* was also observed in D.C. of varying intensities

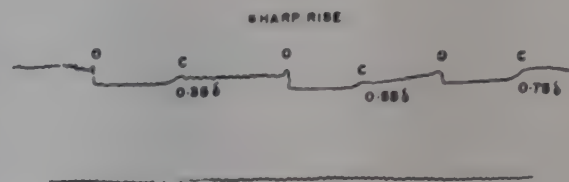


Fig. 1. Effect of sharp increase in A. C. current on heart beat of *H. fossilis*

(0.12 to 1.2δ). Studies in man and animals with A.C. indicated the occurrence of ventricular fibrillation (Novotny & Priegel, 1974). The heart of *H. fossilis*, when exposed to A.C. with slowly rising intensity, exhibited staircase phenomenon (Starling, 1947) at current densities of 0.1δ cardiac slowing at 0.55δ and irregular fluttering at 0.75δ. In sharp current rise, cardiac arrest occurred in relaxation phase even at 0.35δ. Switching off current flow immediately after stoppage of heart beat, regained the normal rhythm once again indicating that the period of exposure in relation to current intensity is responsible for inhibition of heart rate (Fig. 1). The inhibiting effect of  $\text{CaCl}_2$  solution and the accelerating effect of KCl on heart muscle (Starling, 1947) was confirmed from the present tests also, where the heart of *H. fossilis* stopped in a tonically contracted condition, when stimulated through  $\text{CaCl}_2$  solution and continued to contract in the tonically contracted state even during the current exposure while stimulating through KCl solution (Fig. 2).

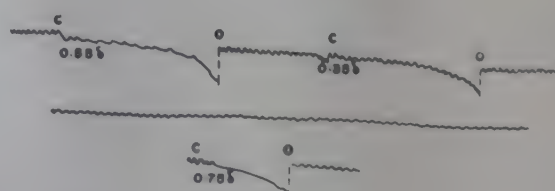


Fig. 2. Effect of A. C. current on heart beat of *H. fossilis* (Medium - Potassium chloride 1:1500)



In the nervous control of locomotion and of movements, the spinal cord clearly plays an important role. Pfluger (1853) severed the spinal cord of eel (*Anguilla anguilla*) immediately behind the medulla oblongata and described various reflexes shown by the posterior portion. Von Holst (1934) concluded that after the spinal section only the anterior part of teleosts (*Carassius auratus*, *Carassius carassius* and *Cyprinus carpio*) showed rhythmical swimming movements, the hind part being motionless excepting when stimulated.

The fishes (*P. ticto*, *H. fossilis* and *T. mossambica*) after spinalization behaved in the similar way as described by Von Holst (1934) when exposed to D.C. shocks of varying intensities. The occurrence of anodic taxis, anodic narcosis and anodic curvature in *P. ticto* and *H. fossilis* were observed in a much lower thresholds as that of intact animal (Biswas, 1974). The un-co-ordinated movement of *T. mossambica* towards the negative electrode in lower threshold than the intact animal (Biswas, 1974) confirmed the findings of Cuinat (1967) that the sharp spinal section allowed the persistence of galvanotaxis at the threshold of the intact animal which became unbalanced through the functional suppression of the cerebellum (spinalization).

Thanks are due to Prof. A. J. Borde, Principal, Wilson College, Bombay for kindly permitting us to work in the zoology laboratory.

## References

- Bary, M. Mck. (1956) *Mar. Res.* **1**, 1
- Brett, J.R. (1957) In *Physiology of Fishes* (Margaret F. Brown, Ed.) Vol. II, p. 121, Academic Press Inc., New York
- Biswas, K. P. (1974) *Studies on the Effect of Electrical Energy on Certain Aquatic Organisms*. M.Sc. Thesis, University of Bombay
- Cuinat, R. (1967) In *Fishing With Electricity, Its Application to Biology and Management* (R. Vibert, Ed.) p.131, Fishing News (Books) Ltd., London, EC4
- Dalziel, C.P. & Lee, W.R. (1968) *Trans. Instn. Elec. & Electron-Eng.* IGA-4,647
- Denzer, H.W. (1956) *Electrical Fishing, Handbuch der Binnenfischerei Mitteleuropas. Schweizerbart'sche Verlagsbuchhandlung. Stuttgart.* **5**, 142
- Holzer, W. (1931) *Fischfang mit Elektrizitat, Elecktrotechu. Ztschr.* **52**, 1442
- Halsband, E. (1968) *Helgolander wiss. Meeresunters.* **17**, 224
- Healey, E.G. (1957) In *Physiology of Fishes* (Margaret E. Brown, Ed.) Vol. II, p.2, Academic Press Inc. New York
- Kuroki, T. (1952) *Bull. Jap. Soc. Scient. Fish.* **18**, 25
- Meyer-Waarden, P.F. (1957) *Electrical Fishing. FAO Fisheries Study No. 7 Food and Agriculture Organization of the United Nations, Rome*
- Novotny, D.W. & Priegel, G.R. (1974) *Dep. Natn. Resour. Tech. Bull.* **73**, 1
- Pfluger, E. (1853) *Die sensorischen functionen des Ruckenmarks der Winbelthiere nebst einer neuen Lehre Uter die-Lietungsgesetze der Reflexionen. A. Hirsch-Wald, Berlin*
- Starling, E.H. (1947) *Principles of Human Physiology.* p.101, J & A. Churchill Ltd., London
- Von Holst, E. (1934) *Z. Vergleich. Physiol.* **20**, 582
- Whelan, F.G. (1950) *Science.* **3**, 496
- William, M.C. (1885) *J. Physiol.* **6**, 192





## Inshore Demersal Fisheries off Orissa Coast

K. P. BISWAS\*

*Co-ordinated Research Project on Utilisation of Trash Fish, Kujang, Paradeep*

Results of bottom trawling in inshore areas off Paradeep with reference to total catch composition and catch per unit effort during 1962-1978 are reported. With increase in fishing effort, benthic species recorded the highest catch in 1969-'70 and thereafter it fluctuated. Fluctuations till 1968-'69 may be due to seasonal migration of fishes. The decline after 1971-'72 can be attributed to overfishing. Off Mahanadi, Devi and Rushikulya river mouths, showed a north-south migration of fishes from October. Presently off Devi river mouth is a rich ground for demersal fishes.

Orissa has 480 km of coast line. The broad continental shelf in the northern region extends from 25 to 35 km and is a rich ground for pelagic fishes (Roy & Roy, 1972). The continental shelf narrows towards south (Borisov, 1962) and is a favourable trawling ground for pelagic and demersal fishes. Even though trawling started in 1962 at Paradeep (Biswas, 1978) attempts to evaluate demersal fishery resources have not been made so far. The present communication based on catch per unit effort (Banerji & Krishnan, 1973) attempts to evaluate the demersal fish stock off Paradeep.

### Materials and Methods

Bottom trawlings were conducted at Paradeep (Lat. 20°15' N, Long. 86°45' E) off Astarang (Lat. 20°N, Long. 86°23' E) and off Damodarpur (Lat. 19°25' N, Long. 85°5' E) situated on Mahanadi, Devi and Rushikulya river mouths (Fig. 1). Wooden trawlers of 9.75 to 13.1 m OAL fitted with 55 to 90 B.H.P. engines were employed. Otter trawls with 18 to 23 m head rope and 2.5 cm stretched cod-end mesh were operated between Mahanadi and Jatadhar river mouths (Fig. 2) at 6 to 15 fathoms during October to March from 0700 h to 1600 h. Duration of each haul varied from 90 to 120 min. Monthly and yearly variations in catch and its composition were recorded for prawns, pomfrets,

clupeiform fishes, polynemids, sciaenids, ribbon fishes, silver bellies, glass fishes and cat fishes. The rest are grouped as miscellaneous. The meteorological conditions were similar to that reported by Biswas (1978). Since data pertaining to the efficiency of nets, fishing techniques and catch were available, the actual fishing performance of steel trawlers alone were evaluated. In wooden trawlers, the fishing efficiency varied with reference to design, size, material and ownership of nets and hence data collected by government trawlers were taken as the basis. In case of private trawlers, the efficiency was calculated by random sampling.



Fig. 1. Location of fishing base

\*Present address: Orissa Maritime and Chilka Area Development Corporation Ltd., Bhubaneswar-3

## Results and Discussion

The total landings from 1962-'78 (Table 1) indicate a maximum of 3,088.92 tonnes during 1975-'76 employing 25 trawlers. As the effort varied with the size of the boat, engine horse power, size of nets, and period of the year, the catch per trawling hour was taken as the index. The total catch per trawling hour was 126.30 kg during 1962-'63 (Table 3). It fluctuated during subsequent years with the highest in 1969-'70 (221.88 kg/h). The catch/h was lowest in 1976-'77 (27.40 kg/h). In spite of fewer boats (4 to 19) operated during 1962-'63 to 1970-'71, the catch per unit

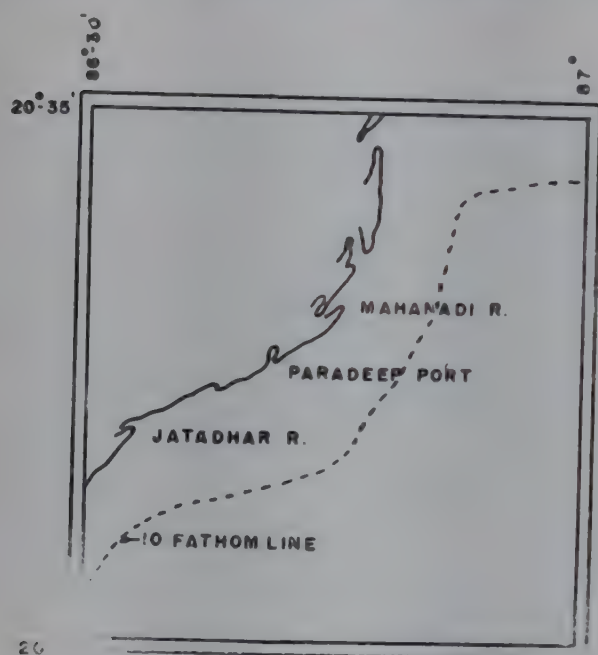


Fig. 2. Trawling ground between Mahanadi and Jatadhar

effort was nearly 2.5 to 8.0 times more than that of 1976-'77. But in 1977-'78, with 5 boats covering 4572 trawling hours (Table 2), the catch rate was only 43.89 kg. It was 126.3 kg/h in 1962-'63, 67.61 kg/h in 1964-'65 and 81.2 kg/h in 1967-'68 even though the fishing effort in those years never exceeded 3886 trawling hours. A substantial increase in fishing effort during 1971-'72 to 1976-'77 failed to increase the catch rate proportionately (Table 3).

From 1962-'63 to 1967-'68, only government trawlers were engaged in fishing. From 1968-'69 onwards, private trawlers started fishing, reaching a maximum of 25 boats in 1975-'76. Consequently, there was

a sudden increase in the fishing effort (37,396 trawling hours) and catch rate (82.60 kg/g) as shown in Fig. 3. With further increase in fishing effort (81,476 trawling hours) in 1976-'77, total catch rate lowered significantly (27.40 kg/h), indicating the attainment of maximum sustainable yield as observed by Gulland (1968). In 1977-'78, by reducing the fishing effort, the catch per hour increased only marginally (43.89 kg/h), suggesting that the increased fishing effort in 1976-'77 completely exploited the fishes in the area and the migration of fishes could not replenish the stock to the earlier level. According to Banerji & Krishnan (1973), when both the catch and catch per unit effort in a steady population shows a downward trend, it can be concluded that the increased fishing activities result in a reduction of the yield, and the fishing effort has to be reduced.

To obtain a measure of the activity of the fishing fleet, estimates for the total trawling hours with catch, percentage of total trawling hours without catch, trawling hours with catch per boat and total boat days availed in the season (Table 2) were made. The first estimate of total fishing effort of steel trawlers was obtained by adding trawling hours with catch and estimated trawling hours without catch per year. The second estimate was arrived at by multiplying boat days and average trawling hours per boat in each fishing season. Allowance was made for the increased efficiency of the vessels, such as higher horse power, use of large synthetic nets and length of towing hours at sea. Saetersdal *et al.* (1965) observed 3% annual increase in fishing efficiency of boats that employ

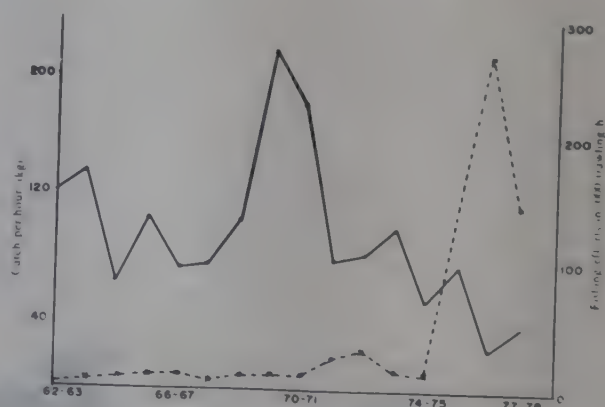


Fig. 3. Correlation between fishing effort and catch per hour



Table 1. Annual trawl landings of demersal fishes at Paradeep

| Year     | Government boats | Total boats in the region | Total catch of prawn and fish by government boats | Total annual landings tonnes |         |
|----------|------------------|---------------------------|---------------------------------------------------|------------------------------|---------|
|          |                  |                           | tonnes                                            | Prawn & fish                 | Prawn   |
| 1962-'63 | 4                | 4                         | 192.99                                            | 192.99                       | 11.54   |
| 1963-'64 | 6                | 6                         | 317.26                                            | 317.26                       | 19.42   |
| 1964-'65 | 10               | 10                        | 262.75                                            | 262.75                       | 23.65   |
| 1965-'66 | 15               | 18                        | 794.54                                            | 794.54                       | 45.13   |
| 1966-'67 | 19               | 22                        | 614.74                                            | 614.74                       | 43.03   |
| 1967-'68 | 11               | 14                        | 250.21                                            | 250.21                       | 27.52   |
| 1968-'69 | 12               | 22                        | 565.79                                            | 1541.49                      | 83.67   |
| 1969-'70 | 13               | 23                        | 1399.60                                           | 2954.65                      | 278.11  |
| 1970-'71 | 10               | 20                        | 911.87                                            | 1912.73                      | 192.85  |
| 1971-'72 | 21               | 29                        | 1708.39                                           | 3249.86                      | 454.55  |
| 1972-'73 | 23               | 31                        | 2468.74                                           | 4599.56                      | 313.74  |
| 1973-'74 | 24               | 36                        | 1110.59                                           | 2292.03                      | 142.90  |
| 1974-'75 | 24               | 41                        | 518.35                                            | 1089.92                      | 235.42  |
| 1975-'76 | 25               | 208                       | 3088.92                                           | 26681.14                     | 3232.75 |
| 1976-'77 | 21               | 344                       | 2232.22                                           | 16029.88                     | 1336.97 |
| 1977-'78 | 5                | 242                       | 200.67                                            | 14102.80                     | 2368.24 |

Table 2. Total fishing effort and estimated fishing effort of all the boats at Paradeep

| Year     | Depth fathoms | Fishing effort of government boats in trawling hours | Trawling hours with catch '000 h | Trawling hours without catch % | First estimate '000 h | Total trawling hours × Average trawling hours '000h | Efficiency factor | Corrected estimate (2nd estimate) '000h |
|----------|---------------|------------------------------------------------------|----------------------------------|--------------------------------|-----------------------|-----------------------------------------------------|-------------------|-----------------------------------------|
| 1962-'63 | 6-10          | 1528                                                 | 1.764                            | 4.69                           | 1.847                 | 1.568                                               | 0                 | 1.568                                   |
| 1963-'64 | 6-10          | 2245                                                 | 2.754                            | 4.94                           | 2.890                 | 2.448                                               | 0.257             | 2.511                                   |
| 1964-'65 | 6-10          | 3886                                                 | 4.500                            | 7.63                           | 4.843                 | 4.000                                               | 0.443             | 4.177                                   |
| 1965-'66 | 6-10          | 7080                                                 | 10.545                           | 7.99                           | 11.387                | 9.490                                               | 1.474             | 10.889                                  |
| 1966-'67 | 6-10          | 7676                                                 | 11.350                           | 9.37                           | 12.413                | 10.215                                              | 1.666             | 11.917                                  |
| 1967-'68 | 6-10          | 3080                                                 | 5.605                            | 9.81                           | 6.155                 | 5.605                                               | 1.177             | 6.265                                   |
| 1968-'69 | 11-15         | 5064                                                 | 15.930                           | 11.45                          | 17.754                | 11.947                                              | 1.884             | 14.198                                  |
| 1969-'70 | 11-15         | 6308                                                 | 15.816                           | 11.96                          | 17.708                | 11.862                                              | 1.927             | 14.148                                  |
| 1970-'71 | 11-15         | 4864                                                 | 12.948                           | 13.00                          | 14.631                | 10.790                                              | 2.326             | 13.300                                  |
| 1971-'72 | 11-15         | 20332                                                | 37.854                           | 18.35                          | 44.800                | 31.545                                              | 1.838             | 37.343                                  |
| 1972-'73 | 11-15         | 28032                                                | 48.930                           | 21.56                          | 59.479                | 40.775                                              | 1.829             | 48.232                                  |
| 1973-'74 | 11-15         | 10324                                                | 23.178                           | 22.59                          | 28.414                | 21.246                                              | 2.003             | 25.501                                  |
| 1974-'75 | 11-15         | 8824                                                 | 19.302                           | 25.03                          | 24.133                | 19.302                                              | 2.183             | 23.515                                  |
| 1975-'76 | 20-25         | 37396                                                | 387.109                          | 26.93                          | 491.357               | 265.446                                             | 3.511             | 358.644                                 |
| 1976-'77 | 20-25         | 81476                                                | 674.739                          | 28.01                          | 863.733               | 501.234                                             | 3.556             | 679.472                                 |
| 1977-'78 | 20-25         | 4572                                                 | 411.590                          | 29.84                          | 534.408               | 288.113                                             | 3.406             | 386.244                                 |

larger purse seines. Using data on horse power of boats, size, design and construction of nets, estimates of increase in efficiency as in Table 4 were obtained. A revision has been made of the estimate on the effect of increase in towing hours with no catch on the efficiency (Table 5).

The relative increase in effort was found

significant (Table 2). The total annual landings of demersal fish as a whole and prawn caught in bottom trawl (Table 1) divided by various estimates of fishing effort (Table 2) provided the estimates of catch per unit effort (Table 3). All the estimates of catch per unit effort declined in three stages, that is, from 1962-'63 to

**Table 3.** *Estimates of catch per unit effort at Paradeep*

| Year     | Catch/h of total demersal fish for all the boats operated in the margin |                          |                           | Catch/h of total prawn for all the boats operated in the margin |                           |
|----------|-------------------------------------------------------------------------|--------------------------|---------------------------|-----------------------------------------------------------------|---------------------------|
|          | Government boats kg                                                     | As per first estimate kg | As per second estimate kg | As per first estimate kg                                        | As per second estimate kg |
| 1962-'63 | 126.30                                                                  | 104.46                   | 123.05                    | 6.25                                                            | 7.36                      |
| 1963-'64 | 141.32                                                                  | 109.78                   | 126.35                    | 6.72                                                            | 7.73                      |
| 1964-'65 | 67.61                                                                   | 54.25                    | 62.90                     | 4.88                                                            | 5.66                      |
| 1965-'66 | 112.22                                                                  | 69.78                    | 72.97                     | 3.96                                                            | 4.14                      |
| 1966-'67 | 80.08                                                                   | 49.52                    | 51.58                     | 3.47                                                            | 3.61                      |
| 1967-'68 | 81.24                                                                   | 40.65                    | 39.94                     | 4.47                                                            | 4.39                      |
| 1968-'69 | 113.73                                                                  | 86.82                    | 108.57                    | 4.71                                                            | 5.89                      |
| 1969-'70 | 221.88                                                                  | 166.85                   | 208.84                    | 15.70                                                           | 19.66                     |
| 1970-'71 | 187.47                                                                  | 130.73                   | 143.81                    | 13.18                                                           | 14.50                     |
| 1971-'72 | 84.02                                                                   | 72.54                    | 87.03                     | 10.15                                                           | 12.17                     |
| 1972-'73 | 88.07                                                                   | 72.03                    | 95.36                     | 5.27                                                            | 6.50                      |
| 1973-'74 | 107.57                                                                  | 80.66                    | 89.88                     | 5.03                                                            | 5.60                      |
| 1974-'75 | 58.74                                                                   | 45.16                    | 46.35                     | 9.75                                                            | 10.01                     |
| 1975-'76 | 82.60                                                                   | 54.30                    | 74.39                     | 6.58                                                            | 9.01                      |
| 1976-'77 | 27.40                                                                   | 18.56                    | 23.59                     | 1.55                                                            | 1.97                      |
| 1977-'78 | 43.89                                                                   | 26.39                    | 36.51                     | 4.43                                                            | 6.13                      |

1967-'68, 1969-'70 to 1974-'75 and 1975-'76 to 1977-'78 both in case of prawn and total stock in the area. The significant rise in catch (2 to 4 times) per unit effort in 1968-'69 to 1969-'70 was due to a three-fold increase in fishing effort, introduction of large sized light weight trawl net made of synthetic twine and trawling at 11-15 fathoms (Table 2). But during 1975-'76 an increase of 0.5 to 2 times of catch/h was noticed consequent to 20 times fishing effort compared to previous year. A further increase in effort (74.3%) in 1976-'77 failed to increase either the total catch or catch per unit effort and showed a sharp decline in both the cases. By reducing the effort to 39% in the next year (1977-'78), the catch rate increased to 42.19%, but not to the level of 1975-'76. Thus it may be concluded that the maximum equilibrium yield (Banerji & Krishnan, 1973) has already been achieved in 1975-'76 and further increase in fishing effort will only decrease the catch per unit effort.

**Table 4.** *Estimate of increase in efficiency*

| Year     | Increase in efficiency |
|----------|------------------------|
| 1962-'63 | 0                      |
| 1963-'64 | 2.70                   |
| 1964-'65 | 4.80                   |
| 1965-'66 | 16.02                  |
| 1966-'67 | 18.38                  |
| 1967-'68 | 13.05                  |
| 1968-'69 | 21.27                  |
| 1969-'70 | 21.89                  |
| 1970-'71 | 26.73                  |
| 1971-'72 | 22.51                  |
| 1972-'73 | 23.31                  |
| 1973-'74 | 25.88                  |
| 1974-'75 | 29.12                  |
| 1975-'76 | 48.05                  |
| 1976-'77 | 49.39                  |
| 1977-'78 | 48.54                  |

ribbon fishes, clupeids, polynemids, silver bellies, glass fishes and cat fishes in the order of abundance. The percentage composition of these groups to total catch also followed a similar trend (Table 6). The composition of catch according to Misra

The average catch per hour was 68.56 kg for the different groups, namely, miscellaneous fishes, sciaenids, prawns, pomfrets,



Table 5. Effect of increase in towing hours with no catch on the efficiency

| Year     | Increase in efficiency |
|----------|------------------------|
| 1962-'63 | 0                      |
| 1963-'64 | 2.57                   |
| 1964-'65 | 4.43                   |
| 1965-'66 | 14.74                  |
| 1966-'67 | 16.66                  |
| 1967-'68 | 11.77                  |
| 1968-'69 | 18.84                  |
| 1969-'70 | 19.27                  |
| 1970-'71 | 23.26                  |
| 1971-'72 | 18.38                  |
| 1972-'73 | 18.29                  |
| 1973-'74 | 20.03                  |
| 1974-'75 | 21.83                  |
| 1975-'76 | 35.11                  |
| 1976-'77 | 35.66                  |
| 1977-'78 | 34.06                  |

et al. (1972) based on landings of 1969-'70 to 1971-'72 does not agree with the average percentage composition calculated in this study.

The average monthly variation of catch increased from 16.92 to 40.91 kg/h (November to March). The catch rate of prawn, pomfret, ribbon fish and cat fish declined

from March, their peak landing was from December to February. In other groups the catch increased still further in March, but to a lesser degree, compared to the percentage of their increase in previous months (Table 7). The higher catch rate (more than 4 times) at Paradeep, than at Damodarpur, shows that the areas off Mahanadi river mouth as a better trawling ground than off Rushikulya river mouth. It is interesting to note that, the catch rate of total landings and the majority of fish groups were more in Astarang than at Damodarpur but slightly less when compared to Paradeep (Table 6). Miscellaneous fishes were significantly fewer and quality fishes dominated the catches at Astarang compared to Paradeep suggesting exploitable commercially important demersal fish stock in the area. The catch rate from October onwards increased progressively, reaching the maximum in December and gradually declined till March both at Paradeep and Damodarpur (Table 7). But the highest catch of prawns was in December at Paradeep followed by cat fish in January. Ribbon fish, clupeiform fishes, polynemids, sciaenids and silver bellies concentrated in the area during February and March respectively. The highest catch rate of miscellaneous group and total stock was noticed in March.

Table 6. Regionwise average trawl catch

| Total fishing effort h        | Paradeep<br>20719 |                              |         | Astarang<br>1995 |                              |         | Damodarpur<br>1165 |                              |         |
|-------------------------------|-------------------|------------------------------|---------|------------------|------------------------------|---------|--------------------|------------------------------|---------|
|                               | Total catch       | Compo-<br>sition<br>of catch | Catch/h | Total catch      | Compo-<br>sition of<br>catch | Catch/h | Total catch        | Compo-<br>sition<br>of catch | Catch/h |
|                               | kg                | %                            | kg      | kg               | %                            | kg      | kg                 | %                            | kg      |
| Prawn                         | 138111            | 9.72                         | 6.66    | 20363            | 18.18                        | 10.21   | 595                | 3.02                         | 0.51    |
| Pomfret                       | 93815             | 6.60                         | 4.53    | 9386             | 8.38                         | 4.70    | 1819               | 9.22                         | 1.56    |
| Clupeiform fishes             | 65795             | 4.63                         | 3.17    | 1660             | 1.48                         | 0.83    | 608                | 3.08                         | 0.52    |
| Polynemids                    | 16194             | 1.14                         | 0.78    | 79               | 0.07                         | 0.04    | 137                | 0.69                         | 0.12    |
| Sciaenids                     | 439240            | 30.92                        | 21.20   | 46764            | 41.76                        | 23.44   | 5897               | 29.89                        | 5.06    |
| Ribbon fishes                 | 77980             | 5.49                         | 3.76    | 4423             | 3.96                         | 2.22    | 1028               | 5.21                         | 0.88    |
| Silver bellies & glass fishes | 15766             | 1.11                         | 0.76    | 3192             | 2.85                         | 1.60    | 389                | 1.97                         | 0.33    |
| Cat fishes                    | 13828             | 0.97                         | 0.67    | 7507             | 6.70                         | 3.76    | 268                | 1.36                         | 0.23    |
| Eel                           | —                 | —                            | —       | 7928             | 7.08                         | 3.97    | —                  | —                            | —       |
| Carangids                     | —                 | —                            | —       | 2479             | 2.21                         | 1.24    | —                  | —                            | —       |
| Soles                         | —                 | —                            | —       | 1679             | 1.50                         | 0.84    | —                  | —                            | —       |
| Elasmobranchs                 | —                 | —                            | —       | 1877             | 1.68                         | 0.94    | —                  | —                            | —       |
| Miscellaneous                 | 559781            | 39.42                        | 27.02   | 4647             | 4.15                         | 2.33    | 8988               | 45.56                        | 7.71    |
| Total                         | 1420510           | 100.00                       | 68.56   | 111984           | 100.00                       | 56.13   | 19729              | 100.00                       | 16.93   |

Table 7. *Monthly average catch per hour*

|                               | October   |           |             | November  |           |             | December  |           |             | January   |           |             | February  |           |             | March     |           |             |
|-------------------------------|-----------|-----------|-------------|-----------|-----------|-------------|-----------|-----------|-------------|-----------|-----------|-------------|-----------|-----------|-------------|-----------|-----------|-------------|
|                               | Para-deep | Asta-rang | Damo-darpur | Para-deep | Asta-rang | Damo-darpur | Para-deep | Asta-rang | Damo-darpur | Para-deep | Asta-rang | Damo-darpur | Para-deep | Asta-rang | Damo-darpur | Para-deep | Asta-rang | Damo-darpur |
| Prawns                        | 0.47      | 1.6       | 1.37        | 1.11      | 23.79     | 2.33        | 1.40      | 13.14     | 0.73        | 0.46      | 2.38      | 0.51        | 1.07      | 11.80     | 0.24        | 1.06      | 8.55      | 0.06        |
| Pomfret                       | 0.21      | 1.5       | —           | 0.56      | 3.24      | —           | 0.84      | 5.26      | 1.24        | 0.29      | 5.11      | 0.59        | 0.79      | 4.62      | 4.26        | 0.80      | 4.64      | 0.03        |
| Clupeiform fishes             | 0.51      | 0.2       | 1.02        | 1.36      | 1.29      | 1.11        | 3.48      | 0.67      | 3.78        | 4.67      | 1.09      | 2.13        | 4.84      | 0.51      | 2.17        | 5.09      | 0.73      | 0.98        |
| Polynemids                    | —         | —         | —           | —         | 0.02      | —           | 0.59      | 0.03      | —           | 0.66      | 0.08      | —           | 0.59      | 0.02      | —           | 0.78      | 0.03      | —           |
| Sciaenids                     | 2.98      | 2.1       | 2.29        | 5.94      | 23.14     | 2.68        | 10.61     | 26.97     | 4.35        | 12.42     | 44.56     | 3.07        | 13.04     | 7.59      | 3.39        | 14.15     | 7.73      | 1.26        |
| Ribbon fishes                 | 0.28      | —         | 0.35        | 0.47      | 2.66      | 0.37        | 1.89      | 3.23      | 0.41        | 2.44      | 2.86      | 0.39        | 2.49      | 0.94      | 0.43        | 1.81      | 1.56      | 0.29        |
| Silver bellies & glass fishes | 0.10      | —         | —           | 0.12      | 0.45      | —           | 0.17      | 2.97      | —           | 0.34      | 1.26      | —           | 0.29      | 1.77      | —           | 1.21      | 1.25      | —           |
| Cat fishes                    | 0.14      | 0.6       | 0.41        | 0.21      | 5.02      | 0.76        | 0.44      | 2.43      | 0.91        | 0.47      | 6.82      | 0.67        | 0.46      | 1.64      | 0.71        | 0.30      | 2.37      | 0.37        |
| Eel                           | —         | 1.0       | —           | —         | 5.27      | —           | —         | 3.76      | —           | —         | 6.44      | —           | —         | 2.58      | —           | —         | 1.30      | —           |
| Carangids                     | —         | —         | —           | —         | 0.25      | —           | —         | 0.92      | —           | —         | 2.14      | —           | —         | 0.96      | —           | —         | 1.22      | —           |
| Soles                         | —         | 0.8       | —           | —         | 2.14      | —           | —         | 0.62      | —           | —         | 0.93      | —           | —         | 0.50      | —           | —         | 0.51      | —           |
| Elasmobranchs                 | —         | 0.5       | —           | —         | 1.36      | —           | —         | 0.77      | —           | —         | 1.26      | —           | —         | 0.55      | —           | —         | 0.87      | —           |
| Miscellaneous                 | 2.20      | 2.0       | 3.1         | 7.15      | 4.39      | 5.63        | 10.92     | 1.80      | 13.44       | 12.40     | 2.79      | 5.01        | 14.35     | 1.39      | 5.63        | 15.71     | 2.06      | 3.16        |
| Total                         | 6.89      | 10.3      | 8.54        | 16.92     | 73.05     | 12.88       | 30.34     | 62.59     | 24.86       | 34.15     | 77.71     | 12.37       | 37.92     | 34.88     | 16.83       | 40.91     | 32.84     | 6.10        |



At Astarang, during the same period, prawns, clupeiform fishes, soles, elasmobranchs and miscellaneous groups showed a peak in November followed by pomfrets, ribbon fishes and silver bellies in December. In January, polynemids, sciaenids, cat fishes, eel and carangids dominated the catch (Table 7). The demersal fish stock was maximum from November to January. The results show that off Devi river mouth is more productive and under exploited. The fishes appear to migrate to inshore waters from north to south, first to off Mahanadi area in October and off Devi in November.

The co-operation rendered by the officers of State Fisheries Department, Exploratory Fisheries Project (Government of India) and private boat owners at Paradeep is gratefully acknowledged.

## References

Banerji, S.K. & Krishnan, T.S. (1973) *Proc. Symp. Living Resources of the Seas Around India, Cochin, p. 158*

Biswas, K.P. (1978) *Fish. Technol.* **15**, 37

Borisov, N. I. (1962) *Experimental and Exploratory Fishing in the Bay of Bengal, FAO Report to the Government of India, 1466*

Gulland, J. A. (1968) *The Concept of Maximum Sustainable Yield and Fishery Management, FAO Fish Stock Evaluation Branch Report*

Misra, P.M., Roy, A.B. & Sengupta, S.K. (1972) *Proc. Seminar on Mariculture and Mechanised Fishing, Madras, p. 180*

Poliakov, M.P. (1962) *Exploratory Trawling in Bay of Bengal, FAO Report to Government of India, 1573*

Roy, J.C. & Roy, S. (1972) *Proc. Indo-Pacif Fish. Coun.* **15**, 40

Saetersdal, G., Tsukayama, I. & Alegre, B. (1965) *Bol. Inst. Mar. Peru.* **1**, 85





## NOTES

**Distribution of Vitamin B-12 in Some Fishes and Marine Invertebrates**

Vitamin B-12 is an important water-soluble vitamin. It is effective in correcting the abnormal blood pattern and neurologic symptoms of pernicious anemia. Vitamin B-12 is of microbial origin and is present in varying amounts in animal tissues and products. Literature shows that the information is scanty on the occurrence of Vitamin B-12 in Indian fishes. Earlier, Sreeniwasamurthy *et al.* (1955) reported Vitamin B-12 in five genera of fresh water fishes. Banerjee & Chatterjee (1963) have reported the Vitamin B-12 content of fifteen different varieties of fish from Bengal. The present note reports the distribution of Vitamin B-12 in the skeletal tissues and internal organs of several fish species and marine invertebrates.

Fresh samples of marine fishes and invertebrates were collected from Sasoon dock and Versova landing sites. Fresh water fishes were collected from Thana lake. Anterior dorso-lateral white muscle, red muscle and internal organs such as liver, heart and brain of each fish were collected for the assay of Vitamin B-12. Vitamin B-12 was extracted from the tissues at pH 4.5 in the presence of potassium cyanide (AOVC, 1966). The homogenate was diluted appropriately and assayed microbiologically using *Euglena gracilis* z strain as the test organism, the method employed being essentially as described by Guttman (1963). The values of Vitamin B-12 are expressed as microgram per 100 g of fresh tissue.

Table 1 reports the distribution of Vitamin B-12 in the skeletal muscle of several marine and fresh water fishes and marine invertebrates. It is observed that Vitamin B-12 content of white muscle of various fishes varies between 0.05 and 1.5  $\mu\text{g}$ . On an average, it contains 1  $\mu\text{g}$  of Vitamin B-12. The elasmobranch fishes such as sharks and rays have comparatively

lower amounts of Vitamin B-12. It is interesting to note that the muscle of electric ray, *Narcine timlei* does not contain any detectable amount of Vitamin B-12. It is observed that marine and fresh water teleosts do not differ significantly with regard to their B-12 content. Marine invertebrates such as prawns, crabs, lobster, cuttle fish and squilla have comparatively higher concentrations of Vitamin B-12. Significantly higher concentrations are observed in case of prawn, *Matapenaeus brevicornis* (3.2  $\mu\text{g}$ ) and crabs (6 to 12  $\mu\text{g}$ )

Table 2 summarises the distribution of Vitamin B-12 in the red muscle, heart, brain and liver of various fishes. Vitamin B-12 content of the red muscle varies between 3 to 22  $\mu\text{g}$ . On an average it contains about 8  $\mu\text{g}$  of Vitamin B-12. The values indicate that heart is a rich source of Vitamin B-12. In sharks, rays, seer fish and horse mackerel, Vitamin B-12 contents of heart and liver are comparable. It is seen that Vitamin B-12 content of fish brain varies from 1 to 15  $\mu\text{g}$  with an average of about 4  $\mu\text{g}$ .

The results show that internal organs and red muscle are richer sources of Vitamin B-12. It is evident that Vitamin B-12 content of red muscle is similar to that of liver and is richer than the white muscle. The fishes such as Indian mackerel, horse mackerel and other pelagic fishes which have greater proportion of red muscle are potentially richer sources of Vitamin B-12. Chatbar & Velankar (1977) have recorded higher concentration of another B-group vitamin, pantothenic acid in pelagic fishes.

An interesting observation is made from the present investigation. Comparing the occurrence of Vitamin B-12 in liver,

**Table 1.** Vitamin B-12 content in fish skeletal muscle ( $\mu$  g/100g)

| Species                                         | Vitamin B-12 |
|-------------------------------------------------|--------------|
| <i>Scoliodon sorrakowah</i> (Shark)             | 1.10         |
| <i>Sphyrna zygaena</i> (Shark)                  | 0.50         |
| <i>Trygon zugei</i> (Ray)                       | 0.2          |
| <i>Narcine timlei</i> (Ray)                     | Nil          |
| <i>Harpodon nehereus</i> (Bombay duck)          | 0.15         |
| <i>Eleutheronema tetradactylum</i> (Salmon)     | 0.25         |
| <i>Muraenesox telabon</i> (Eel)                 | 8.15         |
| <i>Liza parsia</i> (Mullet)                     | 0.85         |
| <i>Psettodes erumei</i> (Flat fish)             | 0.10         |
| <i>Parexocoetus brachypterus</i> (Flying fish)  | 0.60         |
| <i>Hilsa illisha</i> (Shad)                     | 2.25         |
| <i>Hilsa toli</i> (Chinese herring)             | 0.65         |
| <i>Sardinella fimbriata</i> (Sardine)           | 1.70         |
| <i>Coilia dussumieri</i> (Anchovy)              | 0.80         |
| <i>Rastrelliger Kanagurta</i> (Indian mackerel) | 2.75         |
| <i>Cybium guttatum</i> (Seer fish)              | 2.00         |
| <i>Pampus argenteus</i> (Silver pomfret)        | 0.45         |
| <i>Parastromateus niger</i> (Black pomfret)     | 0.85         |
| <i>Megalaspis cordyla</i> (Horse mackerel)      | 3.15         |
| <i>Caranx sansum</i> (Travelly)                 | 1.12         |
| <i>Scomberoides lysan</i> (Mackerel)            | 0.35         |
| <i>Otolithus argenteus</i> (Doma)               | 0.48         |
| <i>Arius macronotacanthus</i> (Cat fish)        | 0.25         |
| <i>Oseogeneiosus militaris</i> (Cat fish)       | 1.50         |
| <i>Cyprinus carpio</i> (Common carp)            | 0.80         |
| <i>Cirrhina mrigala</i> (Mrigal)                | 0.18         |
| <i>Catla catla</i> (Indian carp)                | 0.05         |
| <i>Cehla bacaila</i> (Chela)                    | 2.30         |
| <i>Clarias batrachus</i> (Cat fish)             | 3.25         |
| <i>Labeo rohita</i> (Rohu)                      | 0.50         |
| <i>Penaeus semisalcatus</i> (Prawn)             | 0.55         |
| <i>Metapenaeus dussumieri</i> (Prawn)           | 1.25         |
| <i>Metapenaeus brevicornis</i> (Prawn)          | 3.20         |
| <i>Metapenaeus monoceros</i> (Prawn)            | 0.70         |
| <i>Scylla serrata</i> (Crab)                    | 0.85         |
| <i>Charybdis enicials</i> (Crab)                | 6.10         |
| <i>Charybdis lucifera</i> (Crab)                | 12.10        |
| <i>Thenus orientalis</i> (Lobster)              | 0.90         |
| <i>Sepia</i> (Cuttle fish)                      | 1.10         |
| <i>Squilla</i> sp.                              | 3.00         |

red muscle and white muscle of Indian fishes with the data given by Higashi (1961) for Atlantic and Pacific ocean fishes, it is seen that the Indian fishes have similar values as those of Pacific ocean fishes, whereas the Atlantic ocean species have higher concentrations of Vitamin B-12. Such

geographical differences are encountered with regard to other minor chemical constituents of fish, the reason for which are not known at present. Thus fish and marine invertebrates are good sources of Vitamin B-12.



Table 2. Vitamin B-12 contents of various organs and red muscle in fish (µ g/100 g)

| Species                                    | Heart | Brain | Liver | Red muscle |
|--------------------------------------------|-------|-------|-------|------------|
| <i>Chiloscyllium indicum</i> (Shark)       | 1.35  | 0.80  | 5.80  | ...        |
| <i>Scoliodon porsorah</i> (Shark)          | 4.50  | 1.00  | 6.40  | ...        |
| <i>Sphyrna zygaena</i> (Shark)             | 7.50  | 2.50  | 1.50  | ...        |
| <i>Rhynchobatus djeddensis</i> (Shark)     | 5.00  | 1.75  | 16.50 | ...        |
| <i>Himantura bleekeri</i> (Ray)            | ...   | 3.20  | 8.50  | ...        |
| <i>Narcine timlei</i> (Ray)                | 5.75  | 4.75  | 8.50  | 8.50       |
| <i>Chirocentrus dorab</i> (Wolf berring)   | 16.50 | 1.20  | 11.50 | ...        |
| <i>Cybium guttatum</i> (Seer fish)         | ..    | 15.00 | 22.50 | 22.50      |
| <i>Megalaspis cordyla</i> (Horse mackerel) | 9.50  | 5.00  | 8.00  | 17.50      |
| <i>Scomberoides lysan</i> (Mackerel)       | 7.50  | 1.10  | 7.25  | 4.70       |
| <i>Mene maculata</i> (Moon fish)           | ..    | 3.50  | 2.50  | 2.50       |
| <i>Otolithus argenteus</i> (Doma)          | 5.50  | 3.50  | 0.80  | ..         |
| <i>Cyprinus carpio</i> (Common carp)       | 10.40 | 6.00  | 7.00  | 4.70       |
| <i>Cirrhina mrigala</i> (Mrigal)           | 16.00 | 8.50  | 3.75  | 3.00       |
| <i>Catla catla</i> (Indian carp)           | 9.00  | 2.40  | 6.00  | 5.50       |

References

AOVC (1966) *Methods of Vitamin Assay*. Hand Book of the Association of Vitamin Chemists, 3rd edn., p. 257, Interscience Publishers, New York

Banerjee, D.K. & Chatterjee, J.B. (1963) *J. Ass. Physns India*. **11**, 983

Chhatbar, S.K. & Velankar, N.K. (1977) *Fish. Technol.* **14**, 165

Guttman, H. N. (1963) In *Analytical Microbiology* (Kavanagh, F., Ed) p. 257, Academic Press, New York

Higashi, N. (1961) In *Fish as Food*. (Borgstrom, G., Ed) Vol. 1, p. 441, Academic Press, New York

Sreeniwasamurthy, Swaminath, M. & Subramanian, V. (1955) *Indian J. Physiol. all. Sci.* **9**, 33

Central Institute of Fisheries Education,  
Bombay

\*S. K. CHHATBAR  
&  
N.K. VELANKAR

\*Present address: Export Inspection Agency,  
Bombay





## LETTER TO THE EDITOR

Sir,

In reply to the "Letter to the Editor" appeared in your esteemed journal 16 (1) p. 53, we furnish the following:

### (1) Equilibrium moisture value (EM)

(a) It has been stated clearly in the 3rd and the 4th lines of the 'abstract' and 16th to 18th lines under 'Results and Discussions' of our paper that the EM value of canned prawn is a fixed value with particular reference to species and experimental conditions. It has never been reported any where in our paper that for all canned prawn it is a fixed value (Page 53, column-2 line 33 in the Letter to Editor) as represented by Shri T. K. Govindan. This indicates that either the author has not gone through the paper carefully or he might have distorted the facts by quoting a portion of a sentence.

(b) The EM values of all the species of canned prawn so far studied earlier [Chaudhuri and Balachandran-Fish. Technol. 1965,2 (1) p. 139] show variations between 72 to 74%. Here again the EM value of *M. monoceros* which was represented in our paper as 72.4. So it is stated that the value lies between 72% to 74%. There is nothing wrong mathematically but at the same time the individual EM values with particular reference to different species are fixed. There is also no 'contradiction' as stated by Shri Govindan (Page 53, column 2, line 45 in the Letter to Editor) except perhaps a little misunderstanding on the part of the author.

(c) The EM values were determined in our paper by:

- i) Graphical method as represented in Fig. 1
- ii) Analytical method as represented under column 8 in Table 1.

However, all the methods have been designated as "not so scientific". We shall be obliged to know any better 'scientific' method from Shri Govindan.

### (2) Analysis of data:

(a) Material balance is a technique to judge the correctness of analytical results, any discrepancy in the material balance will definitely indicate the incorrectness of analysis. In can analysis cheking of the results by material balance is not usually carried out but when an author disregards some findings and draws some contradictory conclusions definitely the results require checking. Shri Govindan has concluded that "it is also against their finding" (Page 49 1st column 18th line—Symposium-1975). Weighing in a rough pan balance (correct to the gramme only) and adopting other conditions as described by him in the letter may be useful in showing the trend of results but it becomes extremely difficult to come to a correct conclusion. However, it seems that the author has not actually done so as stated in the letter which is evident from the figures below:

144.5 gms 82.5 cc (Table 9-symposium 75) i.e. the figures have not been rounded off. Like all other scientists he has taken all care and attention for collecting the data.

(b) It is true that the variations of errors derived from material balance were found to lie on both positive and negative sides as pointed out by Shri Govindan. As the percentage of variations on positive side are 18.2% more than on the negative side, examples were cited only from the positive side. However, the range of variation was found to be -6.7% to -6.9% (Experiment No. 1 (i), No. 2 (iii) Table 8). Does the same magnitude of deviation on both positive and negative sides indicate the correctness of analysis? Error is error, whether it is on the positive side or on the negative side.

(c) According to Shri Govindan there are 25 observations (Table 5 to Table 9). But 22 observations are complete with data by which meterial balance can be calculated.

So example cited by quoting 27.2% of the observations seem to be quite reasonable.

If we express the difference of dry mass from material balance into wet basis which is the usual practice in can analysis and the samples showing variations upto 5 g can on wet basis are considered as the tolerance limit for can analysis (10 samples out of 22) i.e. 45.5% of the observations show fluctuations in weight on either side.

Department of Food Technology &  
Biochemical Engineering,  
Jadavpur University,  
Calcutta-32.

D. R. Chaudhuri  
&  
H. Ganguli

Sir,

In reply to the letter of S/Shri D. R. Chaudhuri and H. Ganguli, a copy of which has been forwarded to me for my comments, I am to state that the method of arriving at the equilibrium moisture content of the canned prawn meat by plotting fluctuations in drained weights against moisture contents of blanched meat is totally unscientific. The graph so obtained gives only the moisture content of the blanched meat at which both the filled and drained weights are the same and has no relevance whatsoever to the moisture content of the drained meat. Presumably, the authors have proceeded with the pre-conceived false notion that when the moisture contents of the blanched and canned meats are both 72.4%, there would not be any fluctuation in drained weight i.e., drained weight would be the same as the filled weight. But this is never the case, since invariably some proteinous matter is dissolved out by the filling brine during processing with simultaneous absorption of water from the brine, resulting in higher moisture contents in the canned meat, excepting in the case of under-blanched material, in which both moisture and protein matter are lost during processing.

If the authors contend that the figures given under Col. 8 of Table 1 of their paper (Fish. Technol., 15, 102) are derived by experiment, any one who has carried out at least some fundamental work on similar

We are afraid that Shri Govindan has written his comments without perhaps going through the paper carefully which however has resulted in the distortion of facts as shown in 1 (a). In technical papers there is nothing wrong in bringing out the error, if any, through scientific discussion which will certainly avoid any undue distortion of facts taking place.

lines has to take these as well as the other values in the table with a pinch of salt. As regards material balance, as I had pointed out in my last letter, 48% of my results showed errors below 2%. But the authors found it convenient to pick out only such of my observations which carried experimental errors higher than 2%.

In commercial practice, it is absolutely impossible to separate the different species of prawns so perfectly as to avoid admixture of species completely. A rough grading according to size is all what is done before blanching. It is also impossible to reproduce identical conditions of blanching namely, brine concentration, temperature, duration of blanching etc. Even under laboratory conditions, which factor also is bound to cause considerable variations in the moisture and salt contents of the blanched meat.

The authors assert in para 1 (a) of their letter that "the EM value of canned prawn is a fixed value with particular reference to species and experimental conditions". However, even when the experiments were conducted with *M. monoceros* under different experimental conditions (cf Table 1, *loc. cit.*), wonderfully enough, the EM was still constant i.e.; 72.4%. In the last para of their paper (Fish. Technol. 15, 103), they observe that the moisture contents of the blanched meats attain constant values



of 58.46% to about 69% (see Fig. 2 also) with increases in blanching time and concentrations of blanching brine and conclude that "irrespective of moisture content of the blanched meat, EM content should be in the range 72.0 to 74.4%", without furnishing any data to substantiate it (compare with the figures 72 to 74% in para 1 (b) of the letter).

However, in the cross reference cited i.e., Fish. Technol., 2, 139, two species namely, *M. dobsoni* and *M. affinis*, have been studied, where the EM depends only upon size i.e., medium: 72.0 to 72.5% and small: 74.03 to 74.86% and species difference refuses to show up its influence.

Central Institute of Fisheries  
Technology, Cochin-682 029.

T. K. GOVINDAN

---

No more correspondence in this regd will be published—Editor







